

Shotcrete

A quarterly publication of the
American Shotcrete Association

MAGAZINE


Volume 18, Number 4 ♦ Fall 2016

www.shotcrete.org

MISCONCEPTIONS OF SHOTCRETE

american
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ASCA

A photograph of five professionals standing in a large industrial warehouse. From left to right: a man in a dark suit, a man in a blue work uniform with a tool belt and yellow boots, a man in a dark suit, a man in a white lab coat holding a clipboard, and a man in a dark suit. They are standing on a red pallet. In the background, there are large stacks of bags of material, some wrapped in clear plastic and others in yellow. The warehouse has a high ceiling with metal beams and lights.

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On the cover: Wet-mix shotcrete placement on a structural wall with two layers of reinforcement.

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Elevated Training

By Bill Drakeley



Over the past few weeks, I found myself in an array of diverse venues within the world of shotcrete. My first job duty took me 1000 ft (300 m) below surface elevation, just under the Hudson River to review a fiber-reinforced shotcrete application. We were doing underground, job-specific training for crew and nozzlemen working on a shaft lining of a water tunnel. The project is using a proven mixture as its concrete material, which must follow a slow and narrow route before being delivered to the hopper. The following day, I was being deposed as an expert witness against a high-volume pool contractor in a large class-action suit involving nearly 20 pools with substandard shotcrete

placement. Lastly, I flew across the country to give a presentation on how, in terms of water retention, wet- and dry-mix shotcrete can be used in lieu of cast-in-place and may, in some cases, have a superior bond to its properly prepared substrate.

Why do I mention my recent activities? Well, as I stood in a shaft hole below the mighty Hudson River, I began to contemplate the quality of my immediate surroundings, as well as in the shotcrete industry as a whole. To be frank, one wrong move in the confined shaft I occupied could have led to injury or worse. As an expert witness, I wondered how one contractor can do things so wrong for so long and still be considered a viable shotcrete contractor. Quality and safety go hand in hand. While giving my presentation, I asked myself and the audience why many quality field applicators, engineers, and specifiers of concrete shy away from the shot product and its ideal placement methods in exchange for a straight-cast box or tank.

One seemingly simple explanation to these questions is quality training, or lack thereof. Those reading this article already understand that industry training needs to be elevated and promoted. ASA does its job for its members. Speaking with the Executive Committee and our Executive Director, Charles Hanskat, we have noticed a considerable jump in technical questions asked by the public regarding swimming pools. In my opinion, this is a direct result of the Pool & Recreational Shotcrete Committee's Position Statements on proper applications and the best practices for pool shotcrete placement. With this information publicly available on the web and in wide circulation, more consumers are questioning their contractor's practice if it deviates from our written positions. The new ACI 506R-16, "Guide to Shotcrete" (prepared by ACI Subcommittee 506-C, Shotcreting-Guide, chaired and assembled by ASA member Lars Balck), aligns with ACI 506.2-13, "Specification for Shotcrete." The coordination between the two documents lets the new Guide serve as a descriptive commentary to help explain the terse requirements of the Specification. These documents act as additional sources of reference on industry shotcrete, and along with other supporting ACI/ASA documentation, make up a comprehensive library of basic "how-tos" on proper placement.

The fact that the available technical data is either very slow to disseminate or does not reach those in the field is a problem. We must encourage companies or individuals who have the goal of becoming an educated and well-versed shotcrete applicator to start with the program being developed by the Contractor Qualification Committee. This committee aims to establish key identifiers in determining contractors'

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ASA President's Message

experience and credibility in the shotcrete world. This ASA-issued qualification will assist engineers and specifiers when they need to determine a contractor's qualifications and appropriateness for specific jobs. Using qualified contractors will lead to higher-quality work executed professionally and often accomplished faster.

Of the three job duties I took part in over the past few weeks, the fallout created by bad shotcrete could have been avoided or remediated if a contractor had these qualifications through proper quality training in the first place. Ideally, the contractor will have the know-how to install quality material built to the engineer's or specifier's performance requirements for strength, serviceability, and durability. The engineer will be confident that the contractor has these abilities and has not cheated the process by hiring under-skilled nozzleman with only a basic ACI certification card. The consumer will be confident in the contractor's abilities and will be less likely to question processes they may not understand.

Underground, infrastructure, repair, ground support, and recreational shotcrete applications vary tremendously. One method of shooting does not fit all. Despite this diversity in applications, we agree that goals for high levels of training for all applications will drive qualified contractors to accept jobs they are most qualified for and elevate the shotcrete brand. Bad press and word-of-mouth based on poor applications hurts our livelihood. For example, in the southern areas of the country, very few specifiers will allow dry-mix shotcrete for commercial applications because of its poor reputation. This unfortunate situation is based on poor application practices within the pool industry, which is primarily due to a fundamental lack of training and quality standards. Furthermore, while these poor practices may have started in the pool industry, the bad reputation they engendered has affected the entire shotcrete industry.

However, this does not mean the process itself is flawed. It simply means that we need to elevate our training program. Let's invest in the ASA Contractor Qualification program. Our hope is that we prevent the class action suits, the dan-

gerous safety issues, and an overall skepticism of the shotcrete process. Accepted qualification programs produced by our knowledgeable and credible association, ASA, loudly proclaims we are proactive in our pursuit of industry-wide excellence and eager to work in partnership with our colleagues in the design and construction of quality concrete structures with shotcrete.



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ASA Publications Committee

By Ted Sofis



It has been quite remarkable to have witnessed firsthand the growth and acceptance of shotcrete over the last decade. The American Shotcrete Association and *Shotcrete* magazine have provided the vehicles to inform and educate engineers, contractors, architects, and owners about the advantages and cost savings of shotcrete. Along with acceptance comes credibility, and it has been a cooperative effort to get to this point. The many hours of committee work we have put in together over the years have developed the programs that we now have in place to advance the industry. Innovative construction techniques, technical papers, and shotcrete project profiles routinely grace the pages of *Shotcrete*

magazine. After publication in the magazine, these are all available electronically on our website in a searchable archive (www.shotcrete.org/pages/archive-search/archive-search.asp) or as back issues of the magazines (www.shotcrete.org/pages/products-services/shotcrete-magazine-archive.htm).

You will see a new look for the magazine premiering in the 2017 Winter issue. As part of our rebranding efforts, first introduced with the launch of our new logo and graphics standards last year, *Shotcrete* magazine has been freshened to match that image. We've also included some updates such as changing our Nozzleman Knowledge column to Contractor's Corner to reflect a broader appeal to the work of the entire shotcrete team. Our upcoming themes for *Shotcrete* magazine in 2017 are: Tunnels/Mining for Spring, Cathodic Protection for Summer, and Pools for Fall. Our Winter issue annually highlights the Outstanding Shotcrete Project Awards and the Fall issue includes the Buyers Guide, which is also the most recent issue we bring regularly to World of Concrete. We take great care to select themes that are relevant for our readers and for our members. We welcome your suggestions for articles or topics, e-mailed to info@shotcrete.org.

ASA has more committees, greater participation, and an ever growing membership. *Shotcrete* magazine has a circulation of 12,000+, primarily in North America, and is also read online by another 5000+ all over the world. Our readers include contractors, suppliers, manufacturers, educators, and students as well as architects, engineers, and specifiers! Our monthly e-newsletter, "What's in the Mix," highlights association news as well as current relevant articles in the concrete industry and links to the electronic version of the magazine.

The magazine has a section for New Products and Processes as well as Industry News. Corporate members may submit information, announcements, or news items at any time to info@shotcrete.org for consideration. We highly encourage our Corporate Members to take advantage of this complimentary opportunity! Different Corporate Members are also profiled in each issue, an additional benefit for our Corporate Members. Many have found that direct advertising in *Shotcrete* magazine is a wise investment to this targeted industry. We bring the magazine to other tradeshow venues and they are frequently referenced and distributed at speaking engagements and in response to inquiries to the office. Advertising in the magazine also gains exposure with your logo (hyperlinked to your website) from both the ASA website and e-newsletter "What's in the Mix."

The Publications Committee presents the Carl Akeley Award at the annual ASA Awards Banquet to acknowledge

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and honor the best technical paper to appear in *Shotcrete* magazine the previous year. This is an opportunity to recognize those who are significant contributors to shotcrete knowledge through our magazine.

I am very proud of how much we have accomplished over the years and I am extremely proud of the magazine. Our committee chairs and spearheaders help us secure content and our authors share their insights and experiences on a variety of topics. We are fortunate to have a dedicated and talented staff in Program Coordinator Alice McComas and Executive

Director Charles Hanskat who put everything together to present such a polished final product. What I value most about ASA are the people that I've worked with and gotten to know over the years. There is something special about sharing information and knowledge with colleagues who work in different parts of the country and perform in different types of applications. *Shotcrete* magazine provides a forum for ideas, discussion, and innovation for all of us in the industry. We are an inclusive organization and welcome participation from all our members.



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Executive Director Update

Full Speed Ahead

By Charles Hanskat, PE, FACI, FASCE, ASA Executive Director



Our Association continues to increase our outreach to the concrete construction industry and ramp up our committee activities. Most of our committees met last October in Philadelphia, PA, and have moved steadily forward in achieving our strategic goals. With the increased level of activity, we also implemented the first dual, parallel committee meeting track so our committees could get a full hour to meet and conduct their business. Highlights of the meetings included:

Our Contractor Qualification Committee had its first face-to-face meeting since its creation at the Spring 2016 Board of Directors meeting. The group is developing a 1-day seminar for shotcrete contractors that will be a prerequisite for the formal contractor qualification program.

The Pool and Recreational Shotcrete Committee reviewed and approved a new position statement on forming and forwarded it on to the Board for final ASA approval.

The Education and Safety Committees are working on an education product for presenting topics on shotcrete safety to our member company crews. Format is still under discussion, but it may be a recorded webinar, or perhaps a DVD.

The Underground Committee is nearing completion of a new Underground seminar that follows the content of the

ACI 506 guide document on specifying underground shotcrete. The Committee anticipates this seminar will become available as ASA's revised AIA/CES presentation "Shotcrete for Underground Construction" later in 2017.

Our Marketing Committee reviewed the recent AREMA trade show where ASA exhibited, as well as considered future potential exhibit opportunities in 2017. The committee also reviewed the new shotcrete brochures that were redesigned to use our new branding. The new brochures include five separate brochures geared toward our primary market segments:

- Repair and Rehabilitation;
- Architectural;
- New Structures;
- Ground Support; and
- Pools, Water Features, and Skateparks.

A task group of the Marketing Committee charged to update our 1-hour on-site seminar also met and finalized the updated Introduction to Shotcrete presentation.

The Membership Committee reviewed the recent AREMA trade show activity and made assignments to follow up on potential new members. They also assessed the list of members suspended over the last 2 years and assigned committee members to follow-up and attempt to have these members rejoin.

The Board of Directors met and reviewed financial state-

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Executive Director Update

ments, certification activity, the inspector program, and committee activities in view of our Strategic Plan. The Board also took a major action for student outreach by establishing an annual scholarship for a graduate student involved with shotcrete at Laval University. We also established a 3-year outreach program to civil engineering and construction management students by presenting a shotcrete seminar at their schools.

Our election of new officers and Board members has been distributed to all voting members and closes December 31, 2016. We are looking forward to our Board and General Membership meeting in mid-January in Las Vegas, NV, in conjunction with World of Concrete. Details on ASA's activities can be found on our "ASA at WOC" page online and a snapshot can be found in the Association News of this issue on page 50.

A new twist on the ASA Spring 2017 Committee Meetings will see the ACI headquarters in Farmington Hills, MI, host these meetings. The ACI Concrete Convention and Exposition – Spring 2017 will be held in downtown Detroit, and Farmington Hills is a suburb of Detroit. The close proximity allowed for a unique opportunity to let everyone see our Association headquarters while holding down costs for this meeting. ASA looks forward to this chance to welcome our membership to the home office!

Also in the Spring, a small group of ASA members will meet (before the ASA Spring Committee meetings) to review and update our Strategic Plan. We've accomplished many of our initial goals, so it seems an opportune time to refresh our roadmap as we complete year three since its development!

As your Executive Director, I've had numerous meetings with other associations including ACI, ICRI, ASCC, and ASTM International to assure our interests in advancing quality shotcrete are properly presented. Also, we've had ASA representatives meet with the California Department of the State Architect to help them develop revised shotcrete tests for their inspectors. I also had the pleasure of presenting a shotcrete segment in the annual University of Minnesota Concrete Conference, where over 525 attendees heard about shotcrete. As always, if you have any questions about ASA or shotcrete, please feel free to contact me.

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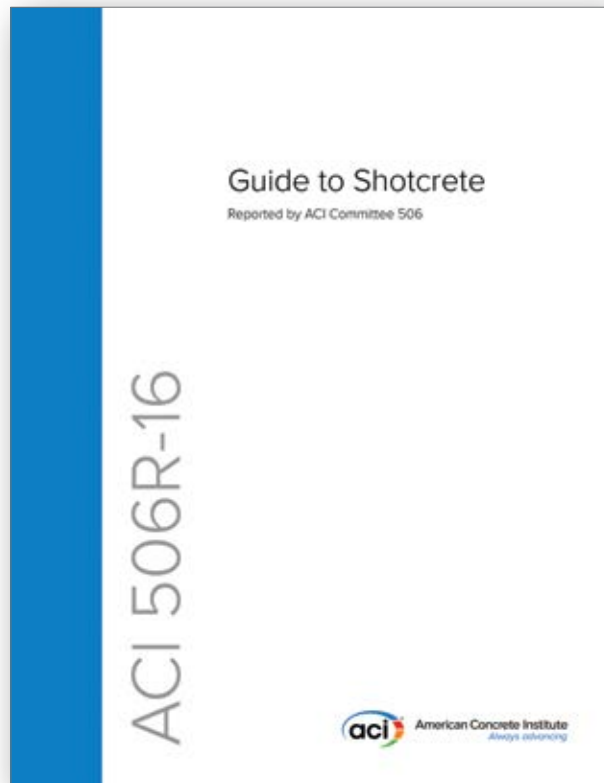
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Shotcrete

2016 Guide to Shotcrete Now Available

The American Concrete Institute announces a new ACI 506R-16, “Guide to Shotcrete” has been published and is now available. Serving as an excellent primer with numerous pictures and figures detailing the entire shotcrete process, the guide includes the history, equipment selection, material requirements, formwork, crew composition and qualification, proper placement techniques, types of finishes, QA/QC testing, and sustainability for shotcrete design and construction. Completely reformatted for 2016, the guide serves as a companion document to the mandatory language in ACI 506.2, “Specification for Shotcrete.” Additional industry-leading education and certification programs are available from the American Concrete Institute and American Shotcrete Association.



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Misconceptions about Shotcrete—True Stories from ASA Technical Inquiries

By Charles Hanskat

As Executive Director and Technical Director for ASA, I get the unique opportunity to tackle a number of technical inquiries every month about shotcrete. Over the last couple of years, we've seen a sharp increase in inquiries from engineers, architects, and owners about pool and water feature installations. Likely part of this increase is the publication on our website of pool position statements (www.shotcrete.org/pages/products-services/shotcrete-resources.htm).

A few of these inquiries were simply questions about best practices, but many have resulted from issues during or after construction. These are true stories. Believe me, I couldn't make some of these up.

Inquiry: A pool owner called and asked, "My shotcrete contractor had some delays while shooting our pool. The concrete got too hard to pump through the machine, so they took the concrete out of the truck in wheelbarrows, and then hand packed the concrete into the remaining open spots in the floor, steps, and benches. The contractor said they do this all the time. Is this OK?"

Misconception: Concrete intended to be shotcreted doesn't need to be physically shot.

Fact: Shotcrete by its definition is concrete pneumatically placed at high velocity. These velocities average from 50 to 80 mph (80 to 125 kmh). The energy released by impact of this high-velocity material provides compaction and consolidation of the concrete. Without the velocity and impact of shooting the concrete, alternative methods of consolidation must be used to eliminate voids and densify the concrete. Hand packing of very stiff, unpumpable material does not provide the compaction effort needed, so likely the concrete in-place has random voids and poor bond to adjacent concrete. Overall, these hand-packed sections will have less strength, reduced durability, and because this is a pool—greater permeability.

Inquiry: A pool owner in Arizona called after cracks formed in their new pool shell. The contractor had told them they needed to "water" the

pool twice a day to prevent cracks, which they did, but cracks still formed.

Misconception: Adequate curing of shotcreted concrete surfaces is just dampening the surface occasionally.

Fact: Proper curing means keeping the concrete surface continuously damp. Curing for 7 days is recommended for shotcrete. Wet curing with water is preferred to using spray-on curing membranes. ACI 308R-01, "Guide to Curing Concrete," states "The objectives of curing are to prevent the loss of moisture from concrete and, when needed, supply additional moisture and maintain a favorable concrete temperature for a sufficient period of time." Curing is essential to allow the cement in the concrete to continue to hydrate. Hydration of the cement is how concrete builds strength, reduces permeability, and improves durability. Because shotcrete has a relatively low water-cementitious materials ratio (w/cm) compared to most placed concrete in floors with w/cm of 0.50 or greater, it would benefit greatly from supplying additional curing water. ACI 308.1-11, "Specification for Curing Concrete," requires for wet curing: "Keep the concrete surfaces continuously wet. Do not allow alternate wetting and drying of concrete surfaces." One would expect that the hot, dry, and potentially windy conditions prevalent in Arizona would create high evaporation rates and wetting the pool surface once or twice a day would not provide a continuous supply of supplemental water.

Inquiry: Another pool owner called about cracking in the coves, benches, and steps in their new pool. Investigating further, they found substantial delaminations and voids below the surface in many of these areas. I asked, "Did you watch the shotcreting procedure?" They answered "Yes." I then asked, "Did you ever see any concrete or material shoveled out of the pool?" Answer: "...No."

Misconception: Some shotcrete contractors feel shotcrete rebound and overspray is able to be left in the floor and coves, or shoveled up into the

benches because it will be covered up by a layer of “good” shotcrete and won’t affect the structural integrity or watertightness of the pool shell.

Fact: When shotcrete impacts a surface, the material that bounces off is called “rebound.” This rebound material is mostly aggregate (sand and rock) and much less paste than in the shotcrete mixture design. Thus, rebound material is substantially weaker and more porous than the shotcrete mixture supplied. When rebound is incorporated in any final shotcreted section, one is introducing a layer of weakness within the concrete section. The section will then not act monolithically, as the designer intended; plus, it gives a weak plane in the shell that will encourage cracking and delaminations when the pool is exposed to wetting/drying and seasonal temperature variations. Rebound and overspray must always be removed and not incorporated in any of the structural pool shell.

Inquiry: An engineer working on a large free-form concrete fountain basin called and asked, “Our shotcrete contractor said we needed to use wet-mix shotcrete because dry-mix is porous and needs extra coatings or plastering to make the fountain basin watertight. Is this true?”

Misconception: Dry-mix is more porous than wet-mix, and not acceptable for liquid-containing pools or structures because it would require additional coating to provide the desired serviceability.

Fact: Dry-mix shotcrete produced with quality materials, good mixture design, proper equipment, and experienced nozzlemen will produce concrete in-place equal to concrete produced using a wet-mix process. Dry-mix will actually tend to have a lower *w/cm*. The perception that dry-mix is more porous may occur because dry-mix water content is controlled by the nozzleman. An inattentive nozzleman or inadequate water pressure may allow dry spots in the work. These areas are definitely more porous, but should not be present in quality shotcrete.

Inquiry: Here’s an interesting inquiry: “The plaster color installed in my pool was the wrong color. The plaster has been chipped out. My concern is damage to the shotcrete shell in the process. There are deep holes, gouges, and there was water seepage in a few areas behind the shotcrete. There is also evidence of honey-combed areas in the shotcrete as well as some other shotcrete concerns since reading up on the shotcrete process. I’m being told that they will just plaster over these concerns. However, the plasterer says that plaster thickness should not exceed 7/8 in. (178 mm) thickness, but can be a little thicker around plumbing fixtures (refer to Fig. 1 and 2).

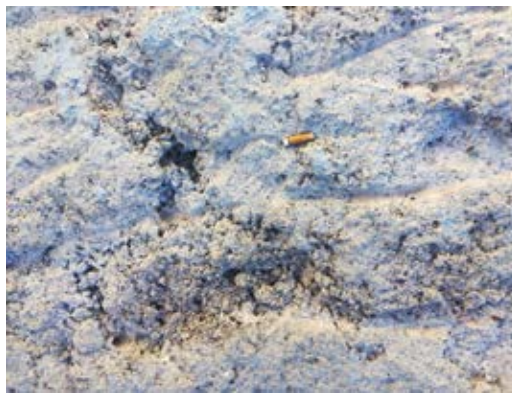


Fig. 1



Fig. 2

Misconception: Shotcrete can be shot rough and without close attention to full compaction because the surface will be covered with plaster and provide the final surface finish.

Fact: ASA has published a position statement, “Watertight Shotcrete for Swimming Pools.” The position statement stresses that shotcrete can and should be built as an essentially watertight structural shell. Further, shotcrete can be finished to very uniform surface tolerances and finishes. A relatively thin, consistent layer of plaster is desired. Properly shotcreted sections should not have any significant voids or sandy, porous, or low-strength sections. From the images, it appears the contractor did not properly place the shotcrete for the pool. Plaster should not be used to fill substantial voids because it has significantly different mechanical properties (strength, thermal expansion/contraction, and shrinkage), and will not provide significant supplemental strength if the shotcreted shell has low strength or porous areas.

Inquiry: “Our pool sat over the winter, and we noticed many areas where the concrete looked sandy or porous. We had cores taken and tested and strengths resulted in 2500 psi (17 MPa). The contract indicated the shotcrete should be 4000 psi (28 MPa). We asked the contractor about the discrepancy, and he said that’s normal. Concrete loses strength over time. Is that correct?”

Misconception: Concrete loses strength over time.

Fact: Concrete usually has a significant amount of unhydrated cement that will hydrate over time. Continuing exposure to moisture and ongoing hydration increases strength, reduces permeability, and thus improves long-term durability. Concrete over 100 years old will still be strengthening. The contractor was wrong in stating concrete loses strength. Also, 2500 psi (17 MPa) is a very low compressive strength and indicates the use of improper materials, equipment, or poor nozzling techniques. ASA maintains that all shotcrete should have a minimum compressive strength of 4000 psi (28 MPa) at 28 days.

Inquiry: I am a structural engineer and we have recently begun work with a shoring contractor. We have been designing soil nails, micropiles, soldier piles, and so on with temporary and permanent shotcrete facings. The contractor has requested that some of our future designs use chain link mesh in lieu of welded wire mesh, particularly in temporary situations with walls under 10 ft (3 m). I understand that chain link is a cost-effective alternative and, according to the contractor, handles the shotcrete great. Is it acceptable reinforcing for shotcrete?

Misconception: Chain link fencing material is adequate for reinforcing shotcrete in underground applications.

Fact: Some mines have used chain link mesh in shotcrete in severely deforming ground and claim that it is better in holding the ground than mesh after large deformations, in which the shotcrete sustains major cracking with deformations. Other than for such unusual applications, we do not recommend the use of chain link mesh in shotcrete. It cannot be fixed "tight" and as such is susceptible to vibration and movement during shooting, resulting in shotcrete sloughing and formation of voids in the shotcrete. Also, the mesh interconnections are conducive to the formation of voids during shooting. Additionally, there doesn't appear to be any consistent material standards on the strength, flexibility, or brittleness of the steel (or other materials) used in the fencing material, so a designer has no way to establish the tensile or flexural strength of the concrete sections. In brief, don't use chain link mesh if you want to produce quality, durable shotcrete.

Inquiry: I've heard that dry-mix shotcrete is not acceptable for exposure to freezing-and-


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thawing conditions because it isn't air entrained. Is this true?

Misconception: Dry-mix doesn't have good freezing-and-thawing durability.

Fact: Dry-mix has decades of good performance in freezing-and-thawing environments, and should not be precluded from use in those exposures. Air entraining is just one aspect contributing to freezing-and-thawing resistance. Good air void spacing in the hardened concrete is the key to good performance of entrained air in concrete. Strength and to some extent permeability also affects performance. Because shotcrete generally has a lower w/cm than conventional form-and-place work, we experience faster strength gain and achieve higher strength over time. Shotcrete also often uses silica fume, fly ash, and other supplementary cementitious materials (SCMs) that increase strength and reduce permeability. Finally, air entraining admixtures are available for use in dry-mix.

Inquiry: I have heard for the best performance of shotcrete, you should avoid finishing and leave as a gun finish. Is this true?

Misconception: Shotcrete should not be finished because it reduces strength, serviceability, or durability of the concrete.

Fact: Shotcrete can be finished in a wide variety of ways, and has little if any detrimental effect on the strength and durability. However, proper finishing techniques should be used. Cutting and finishing (floating or brooming) by experienced finishers will help to produce sections with a consistent surface and section thickness. However, overfinishing or wetting the surface of hardening concrete (in shotcrete or cast concrete) can introduce microcracks in the surface layer. Also, requiring a smooth steel trowel finish will by its inherent nature bring extra paste and water to the surface, increasing the effective w/cm and thus reducing strength of that surface layer. However, this is the result for any cast concrete, and not limited to only shotcrete.

Inquiry: I have been told that I shouldn't use shotcrete because it will have more shrinkage cracks than my cast concrete walls.


Misconception: Shotcrete will have greater shrinkage cracking than form-and-place walls.

Fact: Early-age plastic shrinkage and long-term drying shrinkage are aspects of all concrete work. Plastic shrinkage cracking results from early, quick evaporation of water from the surface of the plastic, hardening concrete. With shotcrete placement, we will have our finished surface exposed to the air. Low humidity and hot or windy conditions will substantially increase the rate of evaporation. Good shotcrete contractors will evaluate appropriate methods to keep the surface damp and minimize or eliminate plastic shrinkage cracks.

Long-term drying shrinkage is related to the paste content, amount and size of aggregate, and the w/cm . Shrinkage cracking is also related to the ability of the concrete to carry tension. The designer of the concrete structure also has a responsibility to design adequate movement joints to accommodate concrete shrinkage. Shotcrete tends to have a relatively high paste content so may have a slightly higher shrinkage potential. Conversely, shotcrete has a lower w/cm (0.30 to 0.42) as compared to most form-and-place (0.40 to 0.50), so would tend to have a lower shrinkage potential. Also, shotcrete tends to have earlier strength gain, and higher 28-day strengths (both compressive and tensile) than most form-and-place concrete. This reduces the shrinkage potentially causing cracks. Thus, considering the pluses and minuses, shotcrete may balance the shrinkage potential of form-and-place. More importantly, proper attention by the shotcrete contractor to the installation, through early, wet curing and keeping curing in place for at least 7 days will significantly help reduce the potential for cracking. Also, shotcrete mixtures can use shrinkage-reducing admixtures that will help limit drying shrinkage through the critical first year after placement.



Charles Hanskat is the current ASA Executive Director. He received his BS and MS in civil engineering from the University of Florida, Gainesville, FL. Hanskat is a licensed professional engineer in several states. He has been involved in the design, construction, and evaluation of environmental concrete and shotcrete structures for over 35 years. Hanskat is also a member of ACI Committees 301, Specifications for Structural Concrete; 350, Environmental Engineering Concrete Structures; 371, Elevated Tanks with Concrete Pedestals; 372, Tanks Wrapped with Wire or Strand; 376, Concrete Structures for Refrigerated Liquefied Gas Containment; 506, Shotcreting; and Joint ACI-ASCE Committee 334, Concrete Shell Design and Construction. Hanskat's service to the American Society of Civil Engineers (ASCE), the National Society of Professional Engineers (NSPE), and the Florida Engineering Society (FES) in over 50 committee and officer positions at the national, state, and local levels was highlighted when he served as State President of FES and then as National Director of NSPE. He served as a District Director of Tau Beta Pi from 1977 to 2002. He is a Fellow of ACI, ASCE, and FES and a member of ACI, NSPE, ASTM International, and ASCC.



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Women in Construction

By Lily Samuels

The shotcrete industry—whether dealing with recreational, infrastructure, or underground applications—is inarguably a male-dominated field. Can this change? If so, why should it, and why should we care?

According to 2014 Bureau of Labor statistics (refer to Table 1), women comprise only 9% of the construction industry in the United States. Considering how—by contrast—women are 51% of the country’s population, this is a significant underrepresentation. It also, however, signifies a tremendous opportunity for the industry’s benefit.

Vast Potential

As a female executive in a reputable luxury shotcrete construction company, I am part of that 9%. I was not born into the construction world, and I didn’t go to school for this or receive any formal training in construction management. And yet, in the course of career transition, I have found a remarkable and rewarding challenge in this industry.

I know I am by no means an exception. There are serious female power players in the shotcrete and pool industries. Furthermore, there are countless other women in other fields who are upwardly mobile, ambitious, and in possession of highly transferrable skills that we have needed to quickly develop to survive in these challenging economic times. These skills—among them a modern aesthetic, polished communication, technological

savvy, commitment to company brand and message, keen sensibilities as consumers, solution-oriented critical thinking, consensus-building, and the list goes on—can pay massive dividends for any company.

My suggestion to the pool, shotcrete, and general construction industries: find these people and hire them. Reach outside the immediate market and access female candidates with multidisciplinary backgrounds, including the social sciences, the arts, STEM (science, technology, engineering, and mathematics), law, and business.

Diversification: New Life

Why should you hire them? Because diversification of your work force is like a shot in the arm, imparting vitality, new ideas, and fresh thinking that can help a company stay relevant.

One thing we know about the pool industry in particular is that it is full of family businesses, many of them multi-generational. It recruits from within: children will get a start in the family shop and then either take the helm or move laterally to other companies in the industry. Anecdotally, we know that many women in the industry hold their positions because their fathers or husbands needed administrative or logistical support while doing field work, so they run the office or back-end operations, or dig further into the business and end up taking over. Many of these women hold important positions in the shotcrete industry today, and their contributions cannot be overstated.

The “legacy” factor of the pool industry is one of its strengths. Every rose has its thorn, however; and in some of these companies, a particular way of doing things might linger for generations and become set in stone just because that is the way it has “always been done.” While these family enterprises are at the heart of American small business, their environments can in some cases become closed off and stagnated, no longer reflecting either the market or resonating with the client they endeavor to serve.

While bearing the utmost respect for the past, I humbly suggest that the rapidly changing world we live in requires a dogged commitment to self-reinvention, growth, and a fearless approach to change. The way business is conducted is constantly evolving. Survival is predicated on the ability to correctly interpret and respond to those

Table 1: 2014 Bureau of Labor statistics

Industry	% of workers
Services	59%
Finance	54%
Wholesale and retail	46%
Public administration	45%
Manufacturing	28%
Agriculture	24%
Transportation	23%
Mining	13%
Construction	9%
All industries	47%

Less than 10% of the construction industry is female, whereas other sectors have much higher rates of female employment
(Source of table: www.osha.gov/doc/topics/women)

changes. Accessing the waves of educated, resourceful, and ambitious women entering the workforce is one such response.

Why Hire A Woman?

I should pause here and clarify. I am not advocating the mass hire of women for its own sake alone. Indeed, no two people are identical; so it is impossible to make accurate sweeping statements about the effects “women” as a singular group would have on the industry.

For instance, the cliché idea that all women are an asset to male-dominated industries because they have a gentling effect on their tough-as-nails male colleagues and sweeten the experience for the client is an oversimplification. Some of the toughest, most driven, direct, and efficient managers I’ve worked under have been women. While calm and controlled, there was nothing gentle about their management style—they demonstrated the grit and incisiveness that the ideal executive should have when the situation calls for it. Similarly, many women have the gift of organization and can get an office running on all cylinders, while others are focused on big-picture strategy and have no bandwidth for the minutia. In my opinion, generalizations about the merits of women as opposed to men are reductionist and unhelpful.

So no, my argument for concerted effort to draw female candidates to the industry is a simple and practical one: untapped resources. Currently, the construction industry pulls 9 of every 10 hires from the male population. Statistically speaking, broadening that hiring pool increases the range of skills and perspectives that a company stands to absorb through its hiring program. The diversification of the available skills in a company is like additional arrows in a quiver or more fuel in a tank.

To be sure, hiring people out of their current fields requires that you both be able to attract them and then retain them. Competitive compensation, health benefits, and a clear growth track are essential components to catching a candidate’s eye and compelling them to sign on. When courting a serious candidate, assume that they will gravitate toward serious opportunities where the potential for both growth and successful contribution is high.

My Story: Old Skills, New Growth

Like I alluded before, my career trajectory to my current position was by no means direct. On the contrary, I entered this field full-time after years of managing my full-time career in international human rights work in New York City and abroad while simultaneously consulting on shotcrete education. Could two industries be more different? Doubtful. The skills, however—

management, organizational, operational, public relations, marketing—transferred well.

Personally speaking, as Vice President of Drakeley Pool Company and Drakeley Industries (our sister consulting firm specializing in shotcrete applications), I was interested in the opportunity to have a critical role in creating growth. With the support of my colleagues throughout the company, I have been able to streamline systems, institute a rebrand that both honors and refreshes our company’s core identity, and actively participate in the execution of our custom shotcrete installations.

However, when asked what my key contribution has been to our two firms, I make an immediate connection back to my previous line of work.

Then, most of my day-to-day tasks involved communicating with key partners literally all around the world. Whether I was up at 3:00 a.m. to make a call to Kenya or writing an e-mail as simply and clearly as possible to a partner in South Sudan whose grasp of the English language was rudimentary, I was constantly striving to be understood correctly.

The only way to do that was to exercise what I describe as “active empathy”—putting yourself as best you can in the other person’s shoes and acting accordingly. And it became engrained in the way I conduct business.



Fig. 1: Lily Samuels, Vice President of Drakeley Industries and Drakeley Pool Company, heads up client relations and general operations at the two firms



Fig. 2: With shotcrete capable of such high-quality, high-value installations, companies stand to benefit from hiring tech- and marketing-savvy professionals who can make sure the firm's brand reaches its target client

So today, in my new line of work, as I work with my clients to realize their vision for their project, those same skills are relevant. I want to understand my client, comprehend what makes them tick, what they need from us, and what they ultimately hope to achieve with the swimming pool or water feature that we are building for them.

I want to find out how they want to be spoken to, what makes them feel heard and understood, and how we can work together creatively. These questions are now at the core of how my staff and I interact with our clients.

Too often in this industry (and only occasionally for good reasons), the client is framed as demanding, unreasonable, and on the opposite team. This could not be a more destructive mindset. It is damaging to consistent positive outcomes with clients, and it is something our company has actively worked to eliminate from our way of thinking. We have changed almost everything about the way we communicate, from our online approach to our collateral materials to the way we answer the phones.

Big Payoff

It's paying off. Our lead conversion rates have gone up significantly: once we begin a dialogue with a client, it becomes clear to them that we are operating in a way that they did not expect but that they deeply appreciate, and that resonates with them as unusual and valuable. Our projects roll out more smoothly, and miscommunication between us and the client is increasingly rare. Upon a project's completion, client feedback almost always touches on our responsiveness and the ease with which questions or problems were answered and resolved.

In short, this is a prime example of how my professional experience in a completely different

sector and field has not only informed my approach but also allowed me to contribute directly to our company's success. Am I particularly good at this kind of communication because I'm a woman? Maybe, but it probably has more to do with the simple fact that I was given opportunities to develop the skills, and now my current company is reaping the benefits.

I share this story not to elevate myself but to point to how hiring from a wide and diverse pool of candidates can elevate a company, and in my opinion, an industry.

There are myriad women of enormous potential who want the chance to distinguish themselves as professionals, have a meaningful effect on a company's success, and launch or continue their careers in a place where their skills will be valued and effective. The construction industries would do well to offer them that opportunity.



Lily Samuels is Vice President of Drakeley Industries, a design and structural shotcrete consulting firm for swimming pools, water tanks, tunneling, mining, and other infrastructural shotcrete applications; and Vice President at Drakeley

Pool Company, a specialty watershape design, construction, and service firm, both located in Bethlehem, CT. She has partnered with Bill Drakeley to develop educational materials on the history and science of the shotcrete process since 2009. Samuels received her bachelor's degree from Smith College, Northampton, MA, and her master's degree from Columbia University, New York, NY.

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Pneumatically Applied Concrete: A Confusion of Terminology

By Charles Hanskat

In recent years, we've heard and seen the term "pneumatically applied concrete" (PAC) used in many discussions and specifications. The term seems straightforward, as it simply describes the act of placing concrete (or mortar) by flow of air through a nozzle. However, we are now seeing specifiers and owners specifying PAC, and apparently not fully understanding the variety of pneumatically placed methods in modern concrete construction and repair.

Evolution of Terminology

According to ACI 506R-16, "Guide to Shotcrete," the term "pneumatically applied mortar or concrete" (PAM or PAC) evolved as a rather generic term early in the 1900s after the proprietary term "gunite" was first established for what we now refer to as the dry-mix shotcrete process. In the 1930s, the American Railway Engineering Association (now known as AREMA) created the term "shotcrete" to replace the proprietary term "gunite" in railroad concrete works. In 1951, the American Concrete Institute (ACI) adopted the AREMA term "shotcrete" because use of tradenames in technical documents was frowned upon. As the wet-mix process developed soon

thereafter, it too adopted the term "shotcrete." "Sprayed concrete" is often used in lieu of the term "shotcrete" in other countries around the world.

As concrete repair materials became more specialized than the original sand and cement mortars, a new process, "low-pressure spraying," was introduced as a method of application to replace hand troweling of spalls. Concrete spall repair sections that the method were designed for were thinner and generally didn't require a high production rate of material placement. Although these spalled sections could certainly be shotcreted, the low-pressure sprayers required less equipment investment, less nozzleman expertise, and due to lower pressure, could be used in tighter spaces with less rebound. However, successful application with low-pressure spraying generally required proprietary, prepackaged cementitious products.

Shotcrete

As we look at the variety of application methods that may be considered PAC, let's first

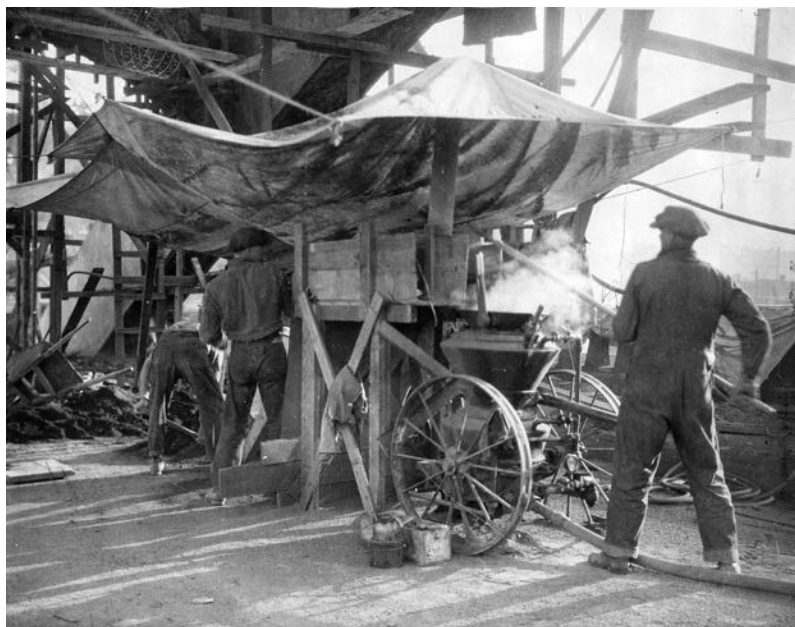


Fig. 1: Dry-mix gun in early 1900s



Fig. 2: Graco low-pressure mortar sprayer

look at shotcrete. ACI CT-16 Concrete Terminology defines shotcrete as “concrete placed by a high-velocity pneumatic projection from a nozzle.” This terminology comes from ACI Committee 506, whose membership includes contractors, engineers, suppliers, and educators intimately involved in the shotcrete business. The key in this definition is high velocity. A study at Laval University by Ginouse and Jolin (*Shotcrete* magazine, Fall 2013) studied particle speeds in both dry- and wet-mix and found average particle speeds in the dry-mix material stream ranging from 45 mph (20 m/s) at the edge to 78 mph (35 m/s) in the centerline. Wet-mix showed a velocity ranging from 56 mph (25 m/s) at the edge to 74 mph (33 m/s) in the centerline.

Why do we need high velocity? Shotcrete placement depends on impact force to compact the concrete, allow the material to flow around obstructions such as reinforcing bars, and minimize voids within the concrete section. Imagine the force of your car driving 60 mph (97 km/h) down the highway, and then impacting an immovable concrete object. There is a massive transfer of energy from the car (and in our case the concrete material) flying through the air, and then suddenly stopping upon impact. One of the prime aspects of proper shotcrete placement is shooting perpendicular to the substrate. This is important because then we’re creating a head-on collision and imparting the maximum energy to consolidation, compaction, and densification of the material in place.

Another aspect of high-velocity shotcrete is high abrasion, and correspondingly excellent bond to existing concrete or previously shotcreted layers. In effect, we are abrasively blasting the substrate, immediately before exposing it to the fresh paste of the cement-rich shotcrete mixture. The impact also drives the fresh paste into the substrate, creating excellent bond of shotcrete when using proper materials, equipment (air compressor size appropriate for the delivery hose and nozzle), and nozzleman placement techniques. Also, using high velocity helps to force fresh material around the back of reinforcement to be embedded in the concrete section.

High velocity can be achieved by using proper air volume. Dry-mix requires more air flow because the full transport of the materials through the delivery hose is accomplished by the air flow. In wet-mix, material delivery is by mechanically pumping through the delivery hose, and air is added to accelerate the concrete mixture only at the nozzle. ACI 506R states that wet-mix shotcrete requires 200 to 400 ft³/min (5.7 to 11.3 m³/min) air volume at 100 psi (7 bar) and dry-mix 350 to 1000 ft³/min at 100 psi (10 to 28 m³/min at 7 bar).

When compared to other methods, such as low-pressure sprayed mortar, shotcrete has the



Fig. 3: Modern dry-mix shotcreting



Fig. 4: Wet-mix shotcreting of structural wall

potential for much higher volume and productivity. Wet-mix can use plant-batched concrete delivered in large ready mix trucks with many cubic yards (cubic meters) in every truck, batched with a concrete batching truck or site-mixed with pre-bagged mixtures in large “super sacks” or smaller individual bags. Dry-mix can similarly be batched with a concrete batching truck or site-mixed with pre-bagged mixtures in large “super sacks” or smaller individual bags.

Shotcrete has some of the most sophisticated concrete mixtures used in the concrete construction market. We shoot overhead and vertical areas, thin or thick, fast set or normal set, and straight or curved sections, delivered from tens of feet to thousands of feet from the supply location. This allows shotcrete to be used in a wide

variety of applications, including underground, foundation walls, ground support, repair or repurposing, domes, cylindrical tanks, pools, and skate parks. Shotcrete is likely one of the biggest users of silica fume and fibers. We also regularly use hydration control, shrinkage-reducing admixtures, and accelerating admixtures. We're even moving into the use of nanoparticle technology to enhance the application and performance of our shotcreted projects.

Shotcrete has many ACI consensus documents directly addressing both dry-mix and wet-mix processes, including ACI 506.2-13, "Specification for Shotcrete," and ACI 506R-16, "Guide for Shotcrete." There is also a comprehensive set of ASTM Standards (C1140, C1385, C1480, and C1604) clearly delineating testing requirements. Additionally, ACI has a well-defined and comprehensive certification for shotcrete nozzlemen in both wet and dry processes and in both vertical and overhead orientations.

Low-Pressure Mortar Spraying

According to ACI Repair Application Procedures, "Spall Repair by Low-Pressure Spraying" (RAP-3), "Similar to wet-mix shotcrete but sprayed at a much lower velocity, low-pressure spall repair spray comes in the form of prepackaged mortar. The spray is applied using small concrete pumps or heavy-duty grout pumps to force the low-slump mortar through a hose. Air is added at the nozzle to impel the mortar. Bond with the prepared substrate is achieved through a combination of proper surface preparation, low-velocity impact, and the material properties of the prepackaged mortar."

The pumped mortar is at a lower pressure than wet-mix shotcrete (200 to 500 lb/in.² [13.7 to 34.5 bar]), and uses very low air flow as compared to either wet-mix or dry-mix shotcrete (10 to 15% of the flow rate). As evidenced by the title of the RAP-3 document, the application method was primarily developed to replace hand troweling of repair material in areas of spalled concrete.

So how does this method compare to shotcrete? There is much less compaction force and surface abrasion of the substrate. Bond depends on the quality of the prepared substrate and mostly on the adhesive properties of the repair mortar. ACI RAP-3 indicates that all low-pressure, spray-applied repair materials are proprietary, prepackaged cementitious products. Finally, with such low pressure and velocity, it is difficult to produce the differential pressure between the air flow and the space behind reinforcement to produce an active flow of material around larger reinforcement. Thus, much of the low-pressure sprayed work is very lightly reinforced with wire mesh or very-small-diameter bars.

It should also be noted there are no clearly established technical standards for materials, equipment, and placement of low-pressure sprayed mortar. ACI RAP-3 appears to be the only document addressing low-pressure spraying but has minimal technical provisions in its less-than-four-page, non-mandatory language overview of low-pressure spraying. A future revision of International Concrete Repair Institute (ICRI) Technical Guideline No. 320.1R, "Guide for Selecting Application Methods for the Repair of Concrete Surfaces," will include more information, but the document is still under development. There is no equivalent to the ACI Shotcrete Nozzleman Certification, and there doesn't appear to be any directly applicable ASTM testing standards.

A "Hybrid" Placement Process

As shotcrete placement was evaluated for thicker, structural sections with dense reinforcement, a hybrid placement process has evolved. Sections with two or three layers of reinforcement, several feet thick, and with reinforcing bars up to No. 11 (No. 36M) have been successfully shotcreted by experienced shotcrete contractors. With dense reinforcement placed in multiple layers, the velocity of the shotcrete (once it reaches the back of the shotcreted section) may be significantly reduced due to impact with the reinforcing bars in the outer layer(s). With the reduced impact force from lowered velocity, the concrete may not be completely consolidated and supplemental consolidation must be supplied. This is usually achieved with a small pencil vibrator to keep the very low-slump concrete from shifting to the front of the section. In these thick sections, the outer layer of reinforcement may very well be properly encased by normal shotcrete techniques.

The shooting of these types of sections has been very successful, and due to the benefits of shotcrete placement including reduced formwork, efficient scheduling, flexibility in placement of the delivery hose, and overall improved sustainability. Being a hybrid process, some have used the term PAC to denote this type of work because the concrete is being placed pneumatically. As this is a developing placement technique, there are no clearly established standards for the hybrid application of shotcrete combining traditional shotcrete application with placing/vibrating. In the future, perhaps ACI 506 will address this hybrid system.

Sorting Out the Confusion of Terms

As you can see, "PAC" is a term applied (for right or wrong) to a variety of processes. PAC in the early 1900s was gunite, where there were no other possibilities. Today's PAC includes a much

more diverse set of processes. Wet-mix was added in the second half of the century and we now have low-pressure sprayed mortar and the hybrid shotcrete/place and vibrate processes. ICRI Technical Guideline 320.1R-92(96) very briefly covers wet-mix and dry-mix shotcrete. A future revision of the document is slated to include low-pressure sprayed mortar. All three will be included in “pneumatically applied methods.”

So at this time, a specifier or owner simply requiring “pneumatically applied concrete” doesn’t necessarily get you high-velocity, high-impact-force shotcrete. It may allow the low-pressure mortar spraying or a hybrid placement process. Low-pressure spraying by its inherent nature cannot provide high velocity, and thus has reduced ability to compact by impact and abrade the substrate to produce enhanced bond. Further, low velocity may well impair the ability of the mortar to flow around larger reinforcing bars and embeds.

ACI CT-16 doesn’t define PAC. However, it does define “pneumatically applied mortar — see shotcrete.” This would seem to exclude low-pressure sprayed mortar because it is pneumatically applied but certainly not at the high velocity required of shotcrete. We will work with ACI to get their terminology aligned with the industry.

So, in summary, what should we learn from this mix of terminology?

- Specifiers and owners need to be aware that PAC is NOT always shotcrete.
- Shotcrete requires high velocity for creating good bond, full compaction, complete encasement of reinforcing bars, and eliminating voids.
- If high-velocity placement cannot be maintained in the structural section due to obstructions (heavy reinforcement or embeds), alternative methods for compaction must be available to densify the concrete mixture in-place.
- Shotcrete has many ACI consensus documents directly addressing both dry-mix and wet-mix processes, including ACI 506.2-13 (Specification) and ACI 506R-16 (Guide), as well as a comprehensive set of ASTM standards for testing requirements.
- There are no clearly established standards for low-pressure sprayed mortar or the hybrid application of shotcrete combining traditional shotcrete application with placing and vibrating.
- Specifiers and owners should always specifically call out shotcrete when they desire placement at high velocity, high abrasion, compaction, and complete encasement of embedded reinforcement.
- When specifiers or owners require shotcrete, they should verify the shotcrete contractor is using equipment (air compressors/delivery

hose/nozzles) that produces enough air flow volume to propel the material at high speed.

In closing, over the last hundred years, we’ve seen shotcrete dramatically improve in the variety of uses, equipment, and quality. As shotcrete has evolved, so has the term “pneumatically applied concrete,” as it now covers a wider variety of concrete placement technologies. Those of us in the industry simply need to be aware of this evolution, and when specifying application methods, be specific about the particular type of application we need for our project.



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Rethinking Shotcrete Mixture Design through Sustainable Ingredients

By Antoine Gagnon, Isabelle Fily-Paré, and Marc Jolin

Awareness of the environment has increased in recent years because the world we built over the past century has left us with several environmental challenges. On one hand, the picture is far from bleak because numerous breakthroughs in science and technology have contributed to improve our health, our comfort, and our productivity. On the other hand, however, we consume more and more resources as the population grows, and we have yet to find a clearly sustainable way to reuse most of these resources.

Concrete can be a valuable asset when it comes to dealing with post-consumer waste materials. There have been numerous research efforts conducted in the last couple of decades to evaluate the potential of alternative materials in concrete mixtures. Some of these alternative materials are post-consumer waste products and are presently collected for reuse in some countries. Unfortunately, there are still very few ways to bring these waste materials back into the cycle of consumption.



Fig. 1: Glass powder from crushed bottles (white), silica fume (gray), and cement

As a solution, the use of these materials to replace or supplement cementitious materials (or aggregates) in concrete is a great way to deal with two sustainability issues. First, it gives a solution for productive use of the increasing generation of waste materials, as it represents an inexpensive and efficient way to give a second life to many products normally sent directly to landfills. Secondly, it lowers the need for consuming natural resources in producing concrete. However, when using new ingredients with significantly different properties than those of traditional constituents, some new and unusual behaviors may be observed and have to be considered.

Recently, some of these alternative materials have been evaluated as potential replacement ingredients in dry-mix shotcrete mixtures in the Laval University's Shotcrete Laboratory (Fily-Paré and Jolin 2013; Gagnon 2016). The key in this kind of study is to think outside the box—any material we have ever put our hands on has the potential to become a suitable ingredient in shotcrete mixtures. It is only a matter of understanding, evaluation, and engineering creativity.

New Materials

Glass is one of the post-consumed materials that has been tested in dry-mix shotcrete mixtures over the last few years (Fily-Paré and Jolin 2013). Glass bottles are widely used in North America, but there has not been much interest in finding them a second life, sending most of the collected glass to landfills. Less than 30% of the collected glass is actually recycled and the rest is discarded (EPA 2012). However, crushing glass into powder is a way to create a new ingredient for shotcrete, offering a more sustainable future for these used glass bottles (Fig. 1).

The use of glass powder (GP) as 20% cement replacement in shotcrete has shown interesting

results when combined with 10% replacement of cement by silica fume (SF). In general, the fine particles (0.04 to 4 mils [1 to 100 μm]) of glass powder allow higher water content in the shotcrete without creating stability issues once on the receiving surface. This is of great interest, as it improves the plasticity of the material, resulting in a lower rebound and a better reinforcing bar encasement (ACI Committee 506 2016; Beaupré and Jolin 2001). An increase in the water-binder ratio (w/b) of the shotcrete, however, can impact the mechanical strength and the overall service life of the structure (Fig. 2).

In fact, some very novel observations were made in the placement phase of GP-shotcrete and can possibly be explained either by a shear thinning or thixotropic behavior created by the glass powder in the cement paste (ACI Committee 238 2014). Such behaviors are fairly new in the dry-mix shotcrete industry and have to be carefully evaluated. In fact, using this kind of material and accommodating such behavior could completely challenge our approach to shotcrete. Once these materials and behaviors are understood and mastered, they could help us significantly improve the quality and performance of dry-mix shotcrete.

More recently, other waste materials have been evaluated in dry-mix shotcrete mixtures, but in this case as replacement for natural aggregates (Gagnon 2016). First, plastic aggregates have been produced from collected plastic containers crushed into small particles (Fig. 3). In general, plastic can be recycled in a sustainable way, but the plastic used in this research comes from the portion of plastic that cannot be properly sorted in the plant, making it unsuitable for recycling and thus for resale.

Secondly, rubber aggregates made from shredded used tires have been used (Fig. 4). Car and truck tires are consumed in large quantities every year, but there are still not many ways to reuse them after their initial life. Therefore, rubber powders have become available in high volumes and are particularly cheap.

Both alternative aggregates have shown workability issues in the case of cast-in-place concrete (Nacif et al. 2013; Saika and Brito 2012). This is why the dry-mix process is the most suitable method to use these products without sacrificing workability. Plastic and rubber have been tested in mixtures at 20% replacement of the total volume of aggregates as a substitute for sand (Fig. 5). The results of this study have shown, as expected, a reduction in mechanical strength due to the poor mechanical properties of these new aggregates. However, the quality of the shotcrete

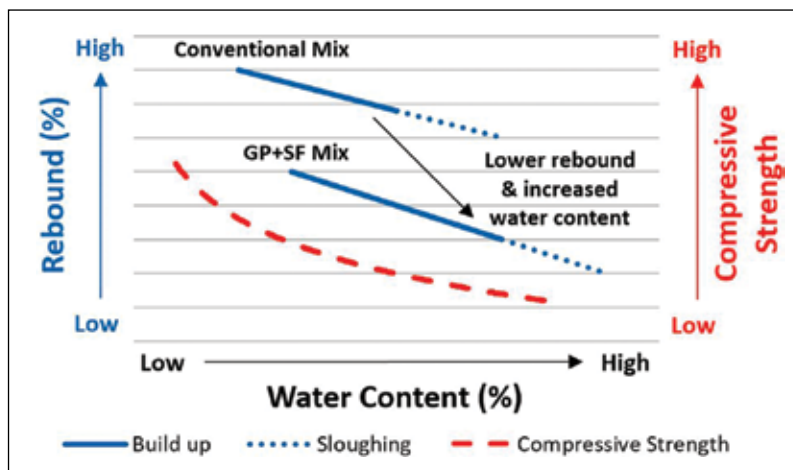


Fig. 2: Behavior of dry-mix shotcrete containing glass powder and silica fume as cement replacement



Fig. 3: Plastic aggregates (0.04 to 0.2 in. [1 to 5 mm]) from crushed plastic containers



Fig. 4: Rubber aggregates (0.04 to 0.12 in. [1 to 3 mm]) from shredded tires

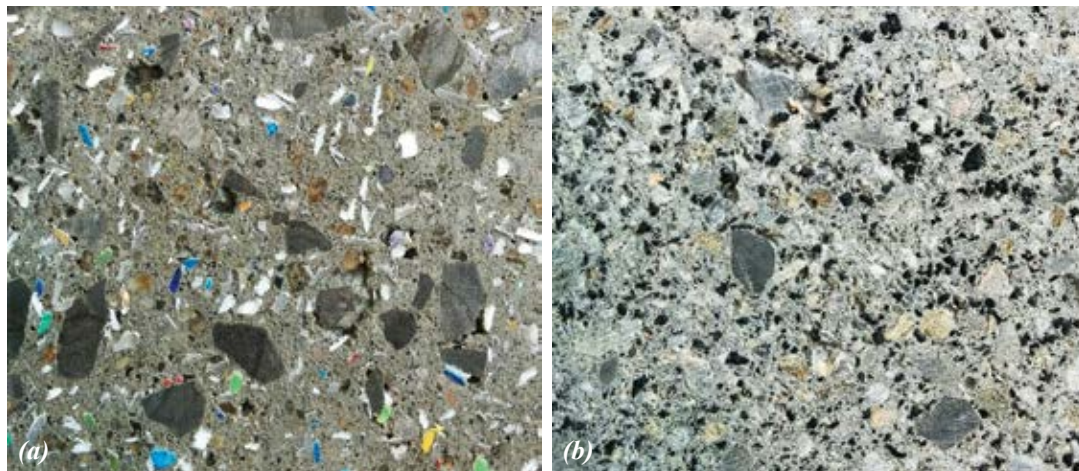


Fig. 5: Substitution of 20% by volume of natural aggregates by: (a) plastic; and (b) rubber

could still be sufficient in many applications considering the large replacement rate used and the possible optimization of the mixtures (Fig. 6). Because of their low stiffness, plastic and rubber

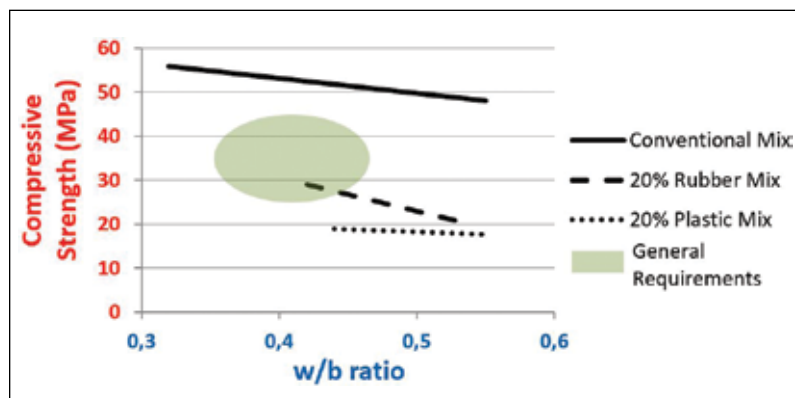


Fig. 6: Strength behavior of dry-mix shotcrete containing rubber and plastic aggregates as sand replacement


aggregates could also have some potential in ground support, where a higher deformability and energy absorption is sometimes sought.

Even though the rubber aggregates did not have any influence on the rebound behavior, they have shown unexpected behaviors in fresh shotcrete. The texture of this shotcrete was nothing like any other one tested before; the consistency of the fresh shotcrete was very soft, but the cohesion was very high at the same time. Also, the mixture generated almost no dust in the shooting even at low water content (pre-bagged material, hydromix nozzle). This result is likely due to improved mixing in the nozzle created by the rubber particles bouncing against the hose or some electrostatic action of the fine rubber particles. This interesting behavior is quite new in dry-mix shotcrete and could have great potential in confined spaces such as tunnels and mines, where the reduction of dust is valuable. It is clear that more research is needed.

Future

Our studies have shown that nontraditional ingredients produced from waste materials can lead to new and very promising behaviors in dry-mix shotcrete, albeit the wettest consistency may not be best practice anymore. The use of all these new sustainable materials challenge the way we have used shotcrete for many years and may help us aim for an ever-improving design of concrete mixtures for shotcrete placement (Fig. 7).

Now that we have some examples of waste products that can be recycled in shotcrete as cement or aggregate replacement, we have to consider unconventional approaches to their use. There are virtually limitless possibilities for us to design new shotcrete mixtures in the pursuit of more sustainable development. Reinventing shotcrete mixtures



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Fig. 7: The future of shotcrete mixture design with sustainable ingredients

with such ingredients could help us realize our need to build and maintain quality structures, and our environmental duties for future generations.

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Antoine Gagnon received his bachelor's degree in civil engineering from Laval University, Quebec City, QC, Canada, where he continues to work toward his master's degree in the same field. The focus of his graduate research is in developing shotcrete mixture designs with added environmental/sustainable value. Toward that end, Gagnon is exploring the reduction of waste associated with shotcrete rebound and inclusion of industrial waste and recycled materials to minimize the use of new resources, all with an eye toward conventional and environmental costs as well as sustainable performance.



After receiving her bachelor's degree in civil engineering from Sherbrooke University, Sherbrooke, QC, Canada, in 2012, **Isabelle Fily-Paré** obtained her MSc in 2015 after working on glass powder in shotcrete. She is currently working on her PhD on durability of glass powder concrete and alkali-silica reaction. She has also worked on two large hydroelectric dam sites in northern Canada, where she organized hundreds of concrete casting and shooting projects.



Marc Jolin, FACI, is a Full Professor in the Department of Civil and Water Engineering at Laval University. He received his PhD from the University of British Columbia, Vancouver, BC, Canada, in 1999. An active member of Centre de Recherche sur les Infrastructures en Béton (CRIB), he is currently involved in projects on service life, reinforcement encasement quality, new admixtures, and rheology of fresh shotcrete. Jolin is an ASA member; an ACI Examiner for Shotcrete Nozzleman Certification (wet- and dry-mix processes); Past Chair of ACI Committee C660, Shotcrete Nozzleman Certification; and current Chair of ACI Committee 506, Shotcreting.

Steel Pipe: More Volume, Less Cost

By Andy Kultgen

Difficult-to-access points-of-placement are common in concrete pumping and are a trademark of shotcrete. A major driving factor behind the development of concrete pumping was the requirement of placing concrete in areas that are out of reach of a ready-mix truck, and may not even be accessible by buggy or bucket. These difficult-to-access jobsites often mean that you must locate your pump far away from where you are placing the concrete, sometimes several hundred feet away. On occasion, typically in mines and tunnels or on bridges, you may need to pump thousands of feet. For many shotcrete and small-line contractors, the go-to pumping delivery line is a rubber hose. It is easy to see why—if you need a flexible line to allow the nozzleman to move around the jobsite and place the concrete around obstructions, why not just get more hoses to cover that ground between the pump and the nozzleman? However, on jobs where you need to pump longer distances or a lot of volume, steel pipeline can be a useful option to decrease the load on your pump, decrease the wear on your hoses, and provide a steady flow of concrete to your nozzleman, all at a lower cost. Those things add up to a better finished product and a better bottom line for your company.

Throughout the last several decades, concrete pumps have increased in power and maximum pressure rating, constantly raising the bar on how far concrete can be pumped. In recent years, high-performance concrete has been pumped well over a thousand feet (300 m) vertically in high-rise construction, and specialized mixtures have been pumped several miles horizontally. Those are the unique and specialized jobs, while the bulk of line concrete pumping is within several hundred feet.

It is not uncommon to explain the wet-mix shotcrete process to a layman and have them remark “You can do that?!” to several aspects of the job. They are surprised that you can pump concrete at all, and equally surprised that you can propel that concrete with compressed air onto a surface and it stays there.

When concrete is pumped, it does not behave like a liquid does when traveling down the line. Concrete moves as a relatively uniform, undis-

turbed ‘slug’ through the line, sliding along on a very thin film of cement, water, and fines. Studies have found that this lubricating paste layer is only about 40 mils (1 mm) thick. When this slug is moving down a straight, uniform pipe, it moves relatively easily. However, bends, reducers and any changes or breaks in the inner surface of the line can cause increased resistance to that slug of concrete moving along because the slug needs to change size or shape, aggregate is forced through the lubricating layer, or the lubricating layer is stripped away. This is the reason why a longer reducer and larger radius bends generally result in easier pumping. The concrete slug has more time to deform; that is, the aggregate rearranges, and less aggregate is forced through the lubricating layer against the pipe wall as it passes through the reducer or around a bend. Aggregate rearranging as more paste moves out to the surface of the slug is the reason you usually experience rock jams in reducers or bends, and rarely in straight sections of pipe.

This slug flow with a thin lubricating layer is the basis for the advantages of steel pipeline. A length of steel pipeline has a smooth, straight inner surface interrupted only by the joint and coupling to the next length of pipe. By comparison, the inner surface of a rubber hose can vary greatly and is not perfectly straight. The inner surface of a hose is generally rougher than a steel pipe, and there are interruptions both where the hose couples to another hose as well as where the steel hose barb starts and ends. It is because of these differences that a rubber hose is generally considered to have three to five times more resistance to pumping than an equal length of steel pipe. Additional benefits of steel pipe over rubber hose are increased wear life, ease of wear life monitoring, and lower cost.

An Example

Consider this situation to illustrate these differences between hose and pipe. A job will require 250 ft (76 m) of line between the pump and the area of placement. The concrete is a typical mixture with a 2.5 in. (64 mm) slump and you expect to pump at a rate of approximately 15 yd³ (11 m³)

Technical Tip

of concrete per hour. You have a trailer pump which can exert a maximum pressure of 1100 psi (7.6 MPa) on the concrete and you have 2 in. (50 mm) diameter pumping line. Using only hose, you would have 250 ft (76 m) of hose (Fig. 1) which yields a proportional value of 750 (assuming a 3× multiplication for hose, which varies from 3 to 5× multiplication.) Using a combination of pipe and hose, you would have 200 ft (61 m) of pipe followed by 50 ft (15 m) of hose (Fig. 2) yielding a proportional value of 350. We will omit the reducers because they are the same for both cases.

Using these proportional length values, refer to the pumping nomograph (Fig. 3). Beginning with the desired pumping rate of 15 yd³ (11 m³) per hour, trace to the right until you hit the line for the 2 in. (50 mm) pipeline size. Then trace downward until you hit the line for your proportional length value. Trace left from that intersection to the line for 2.5 in. (64 mm) slump, and then upwards to the predicted pumping pressure.

The pumping pressure with Option 1, using only hose, will be just above 1000 psi (7 MPa), using nearly all of the pressure available from this

Option 1—Hose Only

- 250 ft (76 m) of hose
- $250 \text{ ft} \times 3 \text{ (hose multiplier)} = 750 \text{ proportional ft (230 m)}$

Fig. 1: Proportional length calculation, Option 1

Option 2—Steel Line and Hose

- 200 ft (61 m) of steel line
- 50 ft (15 m) of hose
- $200 + 50 \text{ ft} \times 3 \text{ (hose multiplier)} = 350 \text{ proportional ft (110 m)}$

Fig. 2: Proportional length calculation, Option 2

pump, and approaching or exceeding the working pressure of many widely available pumping hoses. Adding in the resistance provided by the line reducers near the pump or any higher multiplier values from the hose based on using dirty

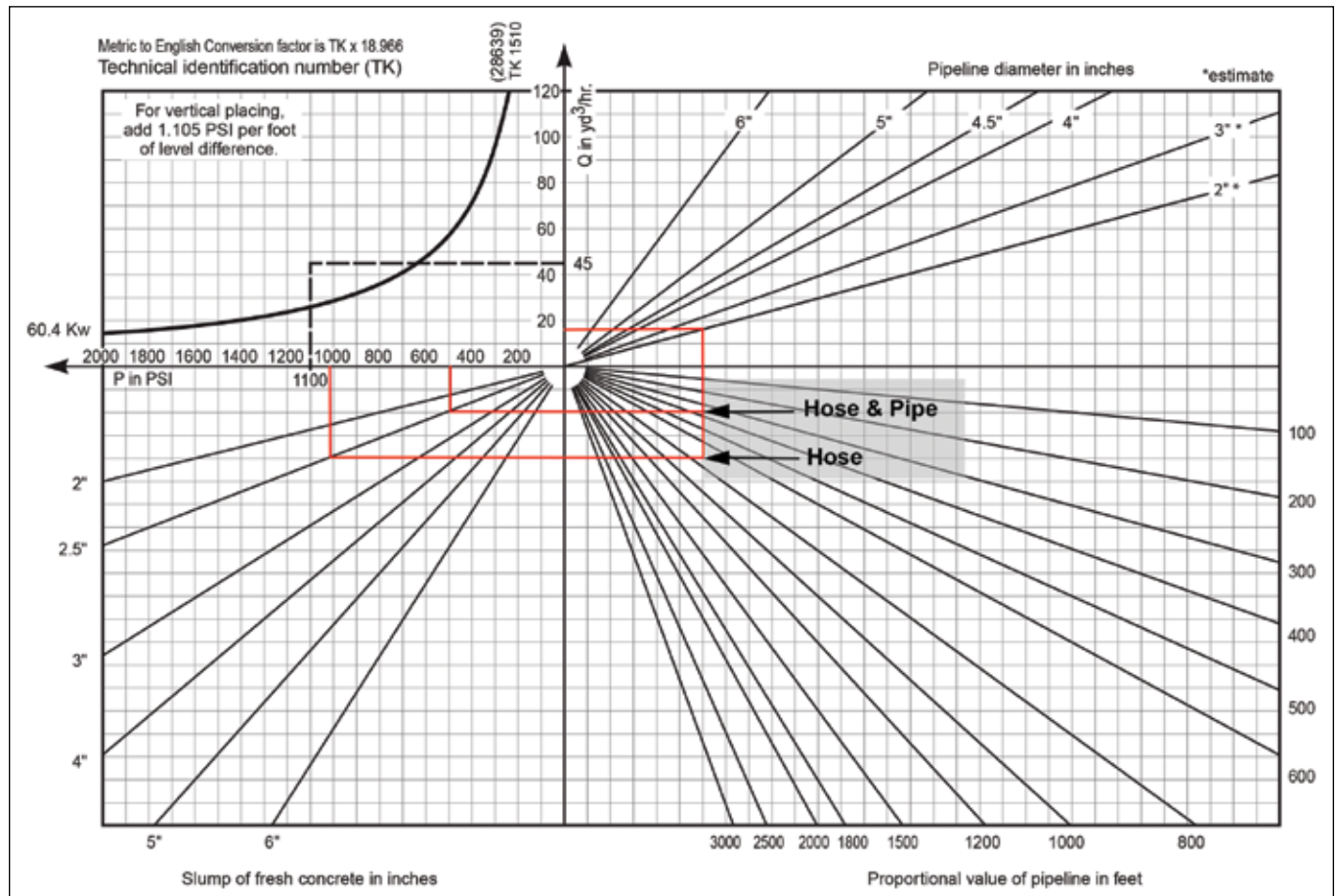


Fig. 3: Concrete pumping nomograph. Nomograph courtesy of Schwing America, Inc.

or worn hoses, and Option 1 may put this job beyond the capabilities of this pump. Conversely, in Option 2, using mostly steel line and a minimal length of hose, the pumping pressure will be under 500 psi (3.5 MPa).

The reduction in pumping pressure achieved by using steel pipeline will result in significant cost savings due to reduced fuel consumption; reduced wear and tear on the pump; and reduced abrasion on the wear parts in the pump, pipeline, and hose. The lower pressures will allow the pump



Fig. 4: The pump operator monitors the pipeline during priming. Using steel pipe enabled this mixture to be pumped at lower pressures



Fig. 5: Using hose only, this pump was pressuring out at 4600 psi (32 MPa) in the hydraulic system, or 1130 psi (7.8 MPa) on the concrete. Replacing 50 ft (15 m) of hose with pipeline lowered pressure to 3400 psi (23 MPa) in the hydraulics, or 835 psi (5.8 MPa) on the concrete

to provide a smoother flow through the line, easing the physical demands on the nozzleman (Fig. 4 and 5). Using steel pipeline instead of hose also allows this smaller pump to be used on longer pushes, avoiding the expense of a higher-pressure pump that would be required if you were using hose alone.

The Brass Tacks

Using steel pipeline in place of hose is not only easier on your equipment but also on your bank account. When comparing equal lengths of steel pipeline and hose, the pipeline will cost less than the hose, even after including several elbows and the extra couplings. The steel pipeline can also be expected to outlast the rubber hose in terms of volume pumped and surviving handling and damage at the jobsite. Steel pipe can tolerate a little rough handling that would kink or tear up the protective jacket of a hose. In cases of a plug, shorter lengths of pipe are easier to handle and clean out. Lower up-front cost, in addition to more volume pumped, is a double win for the pumper.

Of course, rubber delivery hose is necessary in concrete pumping and especially wet-mix shotcrete placement. The flexibility of hose just can't be matched by steel pipeline. Hopefully, the benefits of lower pumping pressure, less wear and tear on pumping equipment, less fuel consumption, lower purchase price, and longer expected lifespan all outweigh that lack of flexibility. With these benefits in mind, I hope you will consider sending your truck or trailer out to the next job with a little less hose and a little more steel pipe.



Andy Kultgen is an Engineer at Construction Forms, Inc., based in Port Washington, WI. Since 2011, he has been involved in research and development as well as technical and field engineering for the concrete pumping and mining industries. He has worked on customized products and layout plans for concrete pumping on several record-setting projects in the United States and around the world. Kultgen received his BS specializing in machinery systems engineering from the University of Wisconsin, Madison, WI. He is active in ASA and ACI, and is focused on furthering research in wet-mix nozzle performance and developing improved nozzle designs, as well as encouraging safe practices in the concrete pumping industry.



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Shotcrete Rising

(Part III of a III Part Series)

By Lily Samuels and Bill Drakeley

The American Shotcrete Association's 2015 Pool of the Year is simply amazing: Designed by Aquatic Consultants (Miami, FL) and engineered by Watershape Consulting (Solana Beach, CA), the ultra-modern custom pool sits on a difficult site and boasts an all-tile interior among a number of other deluxe features.

Truth be told, however, this prize-worthy watershape experienced an unsettling twist on its way to completion: It seems that the original contractor failed to follow established protocols for shotcrete placement, so the resulting shell wasn't of the caliber specified by the engineer to support the pool's interior finish.

The original shotcrete contractor was summarily dismissed from the project. The substandard shell was ripped out, and a replacement was shot by a new contractor, Revolution Gunite (Burlington, NC), which knew how to follow the protocols the first contractor had ignored. With this huge issue resolved, the project stepped back onto its award-winning path.

As we see it, this tale defines two major issues facing the watershaping industry today: first, the need to challenge bad practices and demand excellence; and second, the need to disseminate good information about proper practices to the entire design/build community. In this article, which is the third and last in our series on the developmental history of the shotcrete process, we address this key pair of issues while looking ahead to shotcrete's future.

Out with the Bad

As has been discussed in previous articles, the installation of high-quality shotcrete is not a low-budget endeavor: a qualified, experienced crew must employ the right equipment to place the material, using a good mixture design on a properly prepared substrate. Unfortunately, and all too often, at least one of these three criteria is not respected.

Perhaps this is why so many contractors rely on the waterproofing systems that they consider basic insurance policies. With this added material, they believe they are compensating for any possible flaws having to do with poor or inconsistent application techniques, inadequate mixture formulations, or substandard forming.

Some even market their reliance on waterproofing as an essential "final step"—that is, as an integral part of the shotcrete process. But nothing could be farther from the truth. In fact, the addition of layers atop the concrete material only increases the risk of bond failure.

Through years of experience in critical concrete applications (including the construction of roadway and railway tunnels), we at Drakeley Pool Co. (Bethlehem, CT) know that properly placed shotcrete structures designed to hold water—including swimming pools and spas—are watertight after a 28-day curing period and require no waterproofing before application of the finishing surface.

We also know that waterproofing isn't necessarily an adequate mask for improper shotcrete application. And this is particularly true for projects of the greater level of complexity that are increasingly becoming the norm in high-end watershape design and construction. With swimming pools often being seen as artistic compositions with vanishing edges, perimeter overflows, glass-panel walls, and all-tile finishes, the construction processes involved are much more intricate (and expensive) and therefore raise expectations for flawless execution.

To us, flawlessness involves the use of high-performing concrete as a structural foundation that makes it possible to pull all of the specified finishing touches together. In this context, shotcrete failure spells disaster and underscores the need for meeting the concrete industry's mandated performance criteria.

Pool & Recreational Shotcrete Corner



We've used enough shotcrete in critical situations (including this huge tunnel) to know the material's capabilities and the value and importance of good application techniques



Shotcrete forms the subterranean base supporting this rill, made of reclaimed foundation stones, that graces an elegant English-style garden in Connecticut



With careful forming, properly executed shotcrete can create tight tolerances for free form stairs that are comparable to those that can be achieved by cast-in-place concrete. In this case, that execution was a key component of this nature-inspired slot-overflow pool



Shotcrete makes up the body of this radiant, glass-like Lautner-edge project. In addition, it was used to create the full-perimeter surge trough into which the pool's water flows

The Right Stuff

So what's the problem? If the value of proper shotcrete application is so obvious, why is there such a huge disconnect between the expectations of code-observant designers and engineers and the methods of contractors who seem willing to compromise on quality?

Our suspicion is that it's all about the scientific principle of inertia. Without something to make it move, an object at rest will remain that way. The watershaping industry has suffered with a bad case of inertia for a long time now, and it's up to those who know better to do what

Pool & Recreational Shotcrete Corner

it takes to change mindsets and introduce more professionals to the need for excellence in shotcrete application.

Fortunately, the industry has significantly increased the strength and credibility of educational programs related to shotcrete in recent years—indeed, there's now a wealth of resources dedicated to bringing watershapers up to speed with good and accurate information and the best of the available courses and collateral materials for both wet and dry shotcrete are based on guidelines established by the American Concrete Institute (ACI) and the American Shotcrete Association (ASA).

What this means is that, with fair consistency, programs now offered by groups as diverse as the National Swimming Pool Foundation (NSPF), the Genesis Group, the Northeast Spa & Pool Association (NESPA) and the National Plasterers Council (NPC) are in large part aligned with the principles governing ACI's Nozzleman Certification program and ASA's technical review courses.

This is a good situation that will only get better with time. In fact, these programs are already starting to pay noticeable dividends. Many specifiers and engineers are already looking to ACI and ASA as standard-setters for key performance indicators including compressive strength and water-cement ratios. More important, these watershapers are incorporating the ACI/ASA indicators into their bid specifications, effectively binding contractors to follow protocols per contract terms.

Have all aquatic designers rejected the notion that concrete watershapes require waterproofing? Not universally by any means, but more and more of these professionals are calling these days for watertight shotcrete installation before any surface finish may be applied.

At the Nozzle

The importance of expanding participation in ACI Nozzleman Certification within the contractor community cannot be overstressed. In fact, its value is so widely appreciated already that more and more large shotcrete subcontractors are seeking ACI certification for their workforces. It's even reaching a point where such credentials are a basic indicator of proficiency recognized by design professionals, general and specialty contractors, and clients.

This certification isn't a guarantee of quality, but those with the certification are expected to understand the process, know what to expect as application moves forward, and are on a deter-

mined path to greater proficiency. Of course, it also takes extensive experience on top of basic certification to achieve excellence with complex, high-end watershapes—yet, even basic certification is helpful when watershapers compare the credentials of different shotcrete companies.

Another indicator of this new, more rigorous attitude in evaluating shotcrete companies is the fact that more and more plastering companies are taking a harder look at shotcrete and the effects it can have on their finishes. The NPC, for instance, has incorporated relevant information in its educational courses, helping its membership know how to size up a shotcrete job and make smart decisions in the field about whether to move forward with their own work.

Finally, shotcrete contractors themselves are taking ownership of their mixture designs and their expectations about the material being supplied to them by ready-mix suppliers. There is, for instance, a growing awareness of the detrimental effects that low quantities of cement binder material in the mixture has on the final product.

So considerable progress has been and is being made, which is the good news. The bad news is that there are still persistent pockets of old-school thinking—even in the education scene—that threaten to undermine the gains we've all made.

The Association of Pool & Spa Professionals' Builders Manual is a case in point: it includes a variety of quality information on overall pool requirements which we at Drakeley Pool Co. use regularly. But it also offers blatantly incorrect and/or outdated information on some of the structural aspects of shotcrete construction.

It's time to break away from the old-school suppositions and from instruction based on anecdotes and personal preference that is too often given equal time alongside scientific, fact-based criteria established by ASA and ACI.

It's also time for professionals on the periphery of watershaping to shrug off their reliance on dubious opinions and old-school approaches. Many engineers, for instance, do not encounter robust education on shotcrete, which is why so many of them are, to this day, wedded to a belief that casting in place is superior to pneumatic application—and have difficulty focusing on alternatives as a result. Making things even more difficult is the fact that many of these traditionalist engineers had negative experiences with shotcrete that occurred years ago—long before attitudes and approaches to the shotcrete process began to recover and improve.

Pool & Recreational Shotcrete Corner

In addition, it's important to recognize that a growing percentage of the workforce in the construction industries does not have English as its first language. This highlights the need to extend training and education programs with presentations in other languages. That's not a simple task by any means, but it's another source of concern that needs to be addressed—the sooner, the better.

Down the Road

Despite the existence of these challenges to the ascendancy of the shotcrete process and of stubborn pockets of resistance that make universal acceptance of its merits an elusive goal, there are many reasons for optimism.

First, ASA's numerous position papers on shotcrete are already serving as educational tools and will eventually cover all functions related to watershape-related shotcrete application. Opinions are being replaced by facts, in other words, and personal preferences are giving way to standard operating procedures and an unprecedented level of conceptual unity within the affected trades. ACI and ASA are indeed taking command as definitive, binding standard-setters for shotcrete application—and it's all science-based and reproducible instead of opinion-based or self-promoting.

George Yoggy, the father of modern-day shotcrete in the United States, has long proclaimed the shotcrete process as the ideal method for placing concrete and steadily testifies to the fact that a scientifically advanced concrete mixture design, when delivered and consolidated at high velocity, will capably stand the test of time.

He's not a lone wolf: among others, Dr. Lihe Zhang of Zhang Consulting & Testing Ltd. has convincingly documented the successes of shot material compared to cast-in-place material. These results should lead watershapers and engineers to take note and accept only the best. Inadequate compressive strength, automatic waterproofing, and shortcuts in mixture design—all insults to our trade—should become things of the past.

Those who move forward based on proper information and practice will become as accustomed to receiving accolades for the quality of their projects as were the pioneering applicators who worked for the Cement Gun Company in the 1920s and '30s and created structures that, ever since, have stood the test of time.

This is an elevated status toward which all of us should strive.



Lily Samuels is Vice President of Drakeley Industries, a design and structural shotcrete consulting firm for swimming pools, water tanks, tunneling, mining, and other infrastructural shotcrete applications; and Vice President at Drakeley

Pool Company, a specialty watershape design, construction, and service firm, both located in Bethlehem, CT. She has partnered with Bill Drakeley to develop educational materials on the history and science of the shotcrete process since 2009. Samuels received her bachelor's degree from Smith College, Northampton, MA, and her master's degree from Columbia University, New York, NY.



Bill Drakeley is Principal and Owner of Drakeley Industries and Drakeley Pool Company. Drakeley holds the distinction of being the first and only member of American Concrete Institute (ACI) Committee 506, Shotcrete, from the pool

industry. He is also an approved Examiner for the ACI Certified Nozzlemen program on behalf of the American Shotcrete Association (ASA), 2016 President of ASA, an ASA Technical Adviser, a Genesis 3 Platinum member, and a member of the Society of Watershape Designers as well as Chairman of its Advisory Board. Drakeley teaches courses on shotcrete applications at the Genesis 3 Construction School, World of Concrete, and numerous other trade shows. He is a contributor to Shotcrete magazine and other industry publications.

Catching Up

Here are references to the first two parts of this series on the history and development of the shotcrete process:

Part I: "Beginnings," *Shotcrete* magazine, V. 17, No. 3, Summer 2015, pp. 22-24.

Part II: "Shotcrete Reborn," *Shotcrete* magazine, V. 18, No. 2, Spring 2016, pp. 42-45.

ACI Nozzleman Certification and Underground Robotics

By Chris Zynda

I have been in the shotcrete industry for over 50 years. It all started with shoveling sand behind a gunite (dry-mix) machine and then moving on to foreman, superintendent, and ultimately owner of a shotcrete contracting firm.

I have been involved with wet-mix shotcrete for over 45 years. When we started with wet-mix, batch plants had no computers and the concrete mixture was never the same (except you could count on beer cans and large rock).

Fortunately, the shotcrete industry has steadily evolved over the last 30 years with computer-generated concrete mixture designs and state-of-

the-art batching equipment becoming the norm, rather than the exception.

The tunnel and underground industry is one of the world's largest users of shotcrete, both wet- and dry-mix processes. Figure 1 shows hand-nozzling with a dual-chamber dry-mix gun in an underground tunnel. Figure 2 shows hand-nozzling of an underground chamber and shaft with high reach lifts. (Note: No scaffolding required.)

Shotcrete placement with robotic equipment has become commonplace for installing rock support, final tunnel linings, and repair in the underground industry. Figures 3 and 4 show

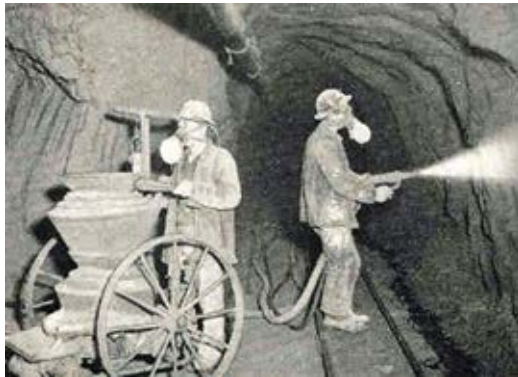


Fig. 1



Fig. 3



Fig. 2



Fig. 4

Goin' Underground

robotic equipment being used for rock support and a tunnel lining. Improved technology with new systems includes use of accelerator injection systems (Fig. 5) that automatically adjust the amount of product to match the stroke of the concrete pump.

I have been involved with the ACI Nozzleman Certification program for over 15 years, being one of the founders of the program and one of the first ACI Shotcrete Nozzleman Certification examiners. With my detailed knowledge of the ACI certification process, I have explained to many tunneling contractors and engineers why they need ACI Nozzleman Certification for the underground shotcrete applications, both hand-nozzled and robotically placed.

Though the term “robotic” is widely used, it often introduces some misconceptions on what the equipment can actually do. In manufacturing plants, robots are usually programmed to endlessly repeat a defined set of operations. It may be welding an auto body or assembling a complicated piece of electronic equipment. In these manufacturing cases, the environment, material supply, and final assembly are well-defined. However, in shotcreted work, we don't have the “well-defined” final assembly—we have a host of variables:

- The underground receiving surfaces are normally quite variable;
- There is a varying amount of reinforcing;
- There may be varying thicknesses due to overcut of the rock;
- Concrete consistency may vary based on age of the mixture;
- Air and water volume and pressure may vary with the length of delivery hose; and
- Temperatures may vary and affect the thickness layers may achieve.

Really, in underground shotcrete, the robotic equipment is a tool for holding the nozzle, and the nozzleman remotely manipulates the nozzle position. This is similar in some ways to the concrete pump operator on a large boom truck who controls the pumping and placement at the end of the delivery hose, or maybe equivalent to a drone operator who controls the location and speed of the flying drone.

Though we use the term “robotic,” shotcrete placement is not preprogrammed or automated in a closely controlled environment. The quality of the final concrete in an underground application depends on the skill of the nozzleman and their knowledge of the various factors essential to quality concrete construction. Thus, the



Fig. 5



Fig. 6

nozzleman must be fully educated on the importance of material selection, properly sized and maintained equipment, proper placement techniques, testing requirements, safety, and finishing (Fig. 6). A quality underground nozzleman should have the basic knowledge and skill for hand-nozzling first, and then they can add the skill to remotely manipulate the nozzle with the robotic equipment.

ACI Shotcrete Nozzleman Certification helps to confirm in a standardized and rigorous way the nozzleman's knowledge of all aspects of basic shotcrete placement, and their ability to properly shoot the performance panel. The ACI Nozzleman Certification program covers the fundamentals for the shotcrete process

Goin' Underground



Fig. 7



Fig. 8



Fig. 9

using the CP-60(15), “Craftsman Workbook for ACI Certification of Shotcrete Nozzleman,” as the key reference for the program. ACI CP-60 has all the information needed to become familiar with topics such as water-cement ratio (w/c) and importance of aggregate gradations. I have mentioned only two topics from this workbook. Do you know how your crews would answer these two questions? Figures 6 and 7 show both vertical and overhead performance panels being placed for the ACI Nozzleman Certification Program.

Shotcrete for producing tunnel final linings is a fairly new application. Due to the availability and use of chemical admixtures, equipment, closely controlled concrete mixtures, and placing and finishing techniques, shotcrete is routinely used for structural reinforced retaining walls and heavily reinforced overhead sections (Fig. 8 and 9).

In summary, underground shotcrete is a huge market around the globe. Advances in shotcrete technology have improved materials and placement equipment, including “robotic equipment.” However, although robotic equipment helps eliminate the physical and safety demands of hand-nozzling, successfully placing quality shotcrete underground is still highly dependent on the knowledge and skill of the nozzleman. The best way for a specifier or contractor to confirm a nozzleman’s knowledge of the basics of shotcrete is to require them to hold a current ACI Shotcrete Nozzleman certification in the process and orientation to be used on the project. ASA’s website (www.shotcrete.org/education/index.htm) has an excellent compilation of nozzleman certification resources from both ASA and ACI.



Chris Zynda is a Past President of the American Shotcrete Association, current President of the Shotcrete Concrete Contractors Association, General Manager with JJ Albanese Concrete—Shotcrete Operations, and an ACI-approved

Examiner for Shotcrete Nozzleman Certification. He is a member of ACI Committees 506, Shotcreting, and C660, Shotcrete Nozzleman Certification, and ASTM Committee C09, Concrete and Concrete Aggregates. Zynda is also an approved Underground Examiner with California Transportation Agency.

Monolithic Shotcrete for Swimming Pools (No Cold Joints)

Shotcrete is the preferred construction method and concrete placement process for structural swimming pool installations. The versatility of shotcrete placement allows for a wide variety of sizes or shapes. Applicable standards for shotcrete design, specifications, and application can be found in American Concrete Institute (ACI) Committee 506 Guides, Specifications, and Technical Notes. Proper shooting technique and nozzle operation are well-covered in CCS-04(08), “Shotcrete for the Craftsman.” Specific pool shotcrete applications are described by the American Shotcrete Association (ASA) Pool and Recreational Shotcrete Committee Position Statements (currently numbered #1-4: “Compressive Strength Values of Pool Shotcrete,” “Shotcrete Terminology,” “Sustainability of Shotcrete in the Pool Industry,” and “Water-tight Shotcrete for Swimming Pools”).

Shotcrete contractors and applicators specializing in swimming pool construction are responsible and liable to observe appropriate design standards, use quality materials, establish appropriate quality control testing, and employ application techniques to build a fully functional pool with long-term serviceability and durability. Two important criteria in a pool shell are the concrete must meet the ASA’s minimum 28-day compressive strength of 4000 psi (28 MPa) (ASA Pool Position Statement #1) and be essentially watertight prior to final surface applications (paint or plaster). These performance criteria assume a monolithic shotcrete pool shell without any cold joints. With shotcrete, the construction of a monolithic shotcrete pool shell is not constrained by time limits as long as proper techniques are observed from surface preparation to mixture design to the shooting velocity of the concrete itself. Shotcrete can be applied in multiple layers, sections, or phases without producing a single cold joint.

The American Concrete Institute’s (ACI’s) Concrete Terminology defines “cold joint” as “a joint or discontinuity resulting from a delay in placement of sufficient duration to preclude intermingling and bonding of the material, or where mortar or plaster rejoin or meet.”

In cast-in-place concrete construction, internal vibration is the most common method for providing adequate consolidation of the placed concrete. In cast-in-place work, a cold joint is formed when an initial lift of concrete becomes too stiff for penetration by the vibrator used to consolidate a subsequent lift. This thus precludes the “intermingling” of material in the definition. However, ACI 309R-05, “Guide for Consolidation

of Concrete,” indicates that if bond is obtained between cast sections, a cold joint is avoided. ACI 309R-05, Section 7.2, states: “When the placement consists of several layers, concrete delivery should be scheduled so that each layer is placed while the preceding one is still plastic to avoid cold joints. If the underlying layer has stiffened just beyond the point where it can be penetrated by the vibrator, bond can still be obtained by thoroughly and systematically vibrating the new concrete into contact with the previously placed concrete; however, an unavoidable layer line will show on the surface when the form is removed.”

Shotcrete does not require internal vibration for consolidation of concrete. Instead, shotcrete provides thorough consolidation and densification by high-velocity impact of fresh concrete material on the receiving surface. Laboratory testing proves that properly placed shotcrete is very well-consolidated, and provides excellent bond strength and durability (Zhang et al. 2016). The high-velocity impact of shotcrete on a hardened, previously shot layer (or existing concrete surface) provides a strong, abrasive blast to open up the surface, and then provides immediate exposure of that hardened surface to fresh cement paste. As a result, properly placed shotcrete exhibits excellent bond to concrete and previously shot surfaces.

A study on shotcrete bond to concrete repair surfaces that included work on multi-layer shotcrete bond was conducted at Laval University (Beaupré 1999). The study looked at bond with multiple layers of shotcrete shot 4 hours, 1 day, and 28 days apart with four levels of surface finishing (no surface finishing, scratched with steel trowel, scratched and finished with wood trowel, and rough broom finish). Table 1 shows the results from Beaupré’s report. The report concluded

Table 1: Multi-layer bond strength in psi (MPa) (Beaupré 1999)

	Type of finish between layers (results with no curing compound)			
Time	None	Scratch	Scratch + wood	Roughen with broom
4 hours	300 (2.1)	260 (1.8)	300 (2.1)	275 (1.9)
1 day	NA	300 (2.1)	300 (2.1)	NA
28 days	NA	260 (1.8)	NA	290 (2.0)

Notes: One-layer full thickness used in this project had a bond (tensile) strength of 350 psi (2.4 MPa); NA is not available



Fig. 1: Floor cast with installed keyway



Fig. 2(a) and (b): Shotcrete on top of cast floor

that “for the waiting period and the types of finish studied, there is no significant influence of these parameters on bond strength” and “With respect to the multi-layer bond strength of shotcrete, the presence of shotcrete/shotcrete interfaces does not seem to create a large reduction in shotcrete quality in terms of mechanical bond if no curing compound is used.”

Specified shotcrete bond strength for shotcrete to properly prepared concrete substrates generally ranges from 100 to 150 psi (0.69 to 1.00 MPa). These levels of bond strength were easily reached by any of the combinations found in Table 1. If a curing compound is used on a layer, it should be completely removed before shooting subsequent layers of shotcrete. In shotcrete construction, surface preparation between layers to provide adequate bond is important. ACI 506.2-13, “Specification for Shotcrete,” specifically addresses this in the requirements of Sections 3.4.2.1 and 3.4.2.2 that:

“3.4.2.1 When applying more than one layer of shotcrete, use a cutting rod, brush with a stiff bristle, or other suitable equipment to remove all loose material, overspray, laitance, or other material that may compromise the bond of the subsequent layer of shotcrete.

Conduct removal immediately after shotcrete reaches initial set.”

“3.4.2.2 Allow shotcrete to stiffen sufficiently before applying subsequent layers. If shotcrete has hardened, clean the surface of all loose material, laitance, overspray, or other material that may compromise the bond of subsequent layers. Bring the surface to a saturated surface-dry (SSD) condition at the time of application of the next layer of shotcrete.”

The shotcrete specification is more stringent than ACI 318-11, Section 6.4, on construction joints, because it requires removal of all potential bond-breaking materials immediately



Fig. 3: Watertight tank test

after initial set, as well as the cleaning and SSD conditions provided for in 3.4.2.2. Thus, shotcrete placed in layers does not produce a “cold joint” as defined by ACI because it produces excellent bond between the layers. This has been confirmed by visual inspection of numerous cores taken through multiple layers of shotcrete, where it is often impossible to identify where one layer stops and the other starts, unlike cold joints in cast-in-place work where the difference between lifts is readily apparent.

The connection point between two or more layers of shotcrete or between days of placement is considered to be a “construction joint.” This joint is still considered to be monolithic based on the shotcrete application methods. Swimming pool shotcrete performance, durability, watertightness, and compressive values depend greatly on the proper application and preparation of the construction joint. Preparation includes shaping the joint to a 45-degree angle, cleaning overspray from adjacent reinforcement not yet embedded, and roughening the surface of the joint with a stiff broom, brush, or tool. The joint can then stand for as long as needed before the next placement. When it is time to complete the area, the joint must be cleaned and predampened to a saturated surface-dry damp condition. When properly shooting and curing the subsequently placed shotcrete, the concrete will act as a monolithic section, just as if there were never a joint there to begin with. The secret in making this a joint that acts monolithically with perfect bond is the combination of the proper surface preparation of the joint and high-impact velocity of the shotcrete stream. Shotcrete is a paste-rich concrete that is pneumatically driven by impact into the rough surface left by the joint preparation. No bonding agents are needed, and indeed no bonding agents should be used because they may interfere with the bond of the fresh paste to the rough substrate.

To reiterate, shotcrete swimming pool construction using quality materials, proper equipment, surface preparation, and placement techniques will not have cold joints and will behave monolithically. Also, with high-velocity impact on a receiving surface, the cement paste penetrates the existing three-dimensional bond plane and requires no bonding agents for proper adhesion between shotcrete layers or applications.

Contributing authors: Bill Drakeley, Charles Hanskat, Chris Zynda

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Position Statements

ASA has produced position statements on the best practices for proper shotcrete placement. To date, five position statements from our Pool & Recreational Shotcrete Committee and one from our Board of Direction have been issued. These statements have also been published in *Shotcrete* magazine.

Visit <http://www.shotcrete.org/pages/products-services/shotcrete-resources.htm>.

New OSHA Rule for Respirable Crystalline Silica

By Mason Guarino

OSHA has created new regulations for respirable crystalline silica. While this doesn't directly affect the shotcrete industry, it does indirectly affect us. As of June 23, 2017, the permissible exposure limit (PEL) for an 8-hour work period will become five times stricter. The current PEL for respirable crystalline silica is 250 micrograms; the new limit will be set at 50 micrograms. Most are familiar with the dangers associated with over-exposure to respirable crystalline silica and it is very easy to access in-depth information about it at www.osha.gov, so this article will not cover the dangers, but will cover where it comes from, how it affects us, and what we can do to be ready for it.

Respirable crystalline silica comes from the destruction of quartz, which is a predominant component of building materials such as stone, sand, brick, concrete, mortar, and other materials that contain products manufactured from the earth's crust. We come in contact with this through the dust created by saw-cutting, grinding, jackhammering, and other forms of breaking up concrete, rock, and other construction building products. The application of shotcrete does not destroy existing components containing silica, but it does contain elements that contain mostly undamaged silica sand and many of our companies do demolition in addition to shotcrete installation.

While we do demolition work, which is often a direct contributor to respirable silica, we should also be aware that there is some in the shooting process itself. In previous tests performed by our safety company and by OSHA, respirable crystalline silica was present. It was well below the PEL at the time and is still below the new PEL; however, instead of being 10 times below the previous PEL and considered to be an ignorable amount, it is now at 50% of the new PEL. These tests were performed in a moderately ventilated area where the dust levels were also below the PEL threshold.

So under normal circumstances, when we are working outdoors or in moderately to well-ventilated areas, we should be within the limits. If your jobsite has tight confines or poorly ventilated areas, some additional steps should be taken, as a lot of us already do.

When we are working in the demolition portion of our jobs, there are a number of ways to handle this. A lot of these methods are already practiced regularly with ventilation fans and respirators. If respirators are to be used, it is important to make sure your employees are properly fit tested and trained for proper use. Moving forward, more eyes will be on us doing these things the right way. OSHA first looks to see if you could have eliminated the hazard before checking to see if personal protective equipment (PPE) is being used properly. Ways to eliminate the hazard include using water to suppress any dust, using tools that have vacuum attachments to capture the dust, using equipment to better ventilate the working area, and isolating the work area to protect others working in the same area. Water and vacuums are self-explanatory and, when demolition work is being performed, should always be used in one way or another. Equipment manufacturing companies use many different ways to adapt water or vacuums for a wide variety of demolition tools.

Making safety equipment easy to use is a good way to keep your employees safe. Using a small tool, such as a 4.5 in. (115 mm) grinder, creates a significant amount of dust, but a 0.75 in. (19 mm) garden hose or 2 in. (50 mm) shop-vac hose aren't necessary to suppress the dust it creates. Small air compressor hoses or other small tubing can easily be adapted to add a small amount of water to the cutting area to control the dust while being much more easily maneuvered than a 0.75 in. (19 mm) garden hose. Additionally, smaller suction lines can be fitted to a shop-vac to contain the dust. Both of these tricks can be used with a number of different tools. Making dust control easier will make it more likely your

Safety Shooter



Fig. 1: This image shows an asbestos-like containment room to contain concrete repair work to its own area so that other trades could safely work around them

employees will use them. Containment also helps manage this work. If your jobsite is indoors in one part of a building and there are other trades in the area, it is your responsibility to contain the dust produced by your work and not make a carpenter's work area hazardous due to your dust. This goes for demolition and the shotcrete placement application. I have had good luck with building asbestos-like containment rooms around my work area and adding air scrubbers to them to capture any dust in the air. This creates a safer work environment for everyone on the jobsite.

Safety is important to the American Shotcrete Association and should be for you and your employees, too. Education and training is crucial in ensuring that everyone goes home safe every day and, in the case of respirable crystalline silica, continues to be able to work safely for years to come.

Visit the OSHA website (www.osha.gov/silica) to familiarize yourself with the new regulations and the preferred ways to mitigate them.



Mason Guarino started in the pool industry when he was 14, learning how to install reinforcing bar. Since then, he has worked on all phases of swimming pool construction. Guarino has been with South Shore Gunite Pools & Spas, Inc., full-time since graduating from the Wentworth Institute of Technology with his BS in construction management in 2009. Guarino currently serves on ASA's Board of Direction and is an ACI Certified Nozzleman.

Shotcrete Calendar

JANUARY 16, 2017

ASA Committee Meetings at World of Concrete

Las Vegas Convention Center
Las Vegas, NV

www.shotcrete.org

Schedule of ASA Committee Meetings

9:00 am — Board of Direction

11:00 am — Annual Membership Meeting

11:30 am — Adjourn

*Both meetings listed above are **open to all** –
No registration required*

JANUARY 17, 2017

ASA Shotcrete Nozzleman Education

9:00 am–4:00 pm

WOC Registration code: **ASATU**

Las Vegas Convention Center
Las Vegas, NV

JANUARY 17, 2017

ASA Outstanding Shotcrete Project Awards Banquet

6:00 pm Reception | 7:00 pm Dinner & Awards

Vdara Hotel & Spa, Vinyol Ballroom
Las Vegas, NV

www.shotcrete.org

JANUARY 17-20, 2017

World of Concrete 2017

Visit ASA's Booth #S10839

Register using ASA's source code: **A17**

Las Vegas Convention Center
Las Vegas, NV

www.worldofconcrete.com

JANUARY 18, 2017

ASA 90-minute Shotcrete Seminar

"Shotcrete Technology: Advances, Research and Challenges in Using Shotcrete"

8:30 am–10:00 am

WOC Registration code: **WE141**

Las Vegas Convention Center, North Hall
Las Vegas, NV

JANUARY 18, 2017

CICL Application of Shotcrete Course (offered in Spanish)

9:00 am–1:00 pm

WOC Registration code: **CICLWE**

Las Vegas Convention Center, North Hall
Las Vegas, NV

JANUARY 23-26, 2017

The Pool & Spa Show (sponsored by NESPA)

Atlantic City Convention Center
Atlantic City, NJ

JANUARY 24, 2016

Seminar: Pool Shell Cracking in Shotcrete/Gunite Construction—A Survey of Case Studies and ASA and ACI Guidelines (Construction 406)

8:30 am–11:45 am

Bill Drakeley, Presenter

www.nespapool.org

MARCH 15-16, 2017

New York Build 2017

The Leading Construction Expo for New York
Javits Center

New York, NY

www.newyorkbuildexpo.com

MARCH 15-17, 2017

ICRI 2017 Spring Convention

Theme: "Bridges and Highways"

Le Westin Montreal

Montreal, QC, Canada

www.icri.org

MARCH 25, 2017

ASA Spring 2017 Committee Meetings

ACI Headquarters

Farmington Hills, MI

www.shotcrete.org

Schedule of ASA Committee Meetings

Time	Multipurpose Room	Meeting Room A
7:30 am–8:30 am	Education	Underground
8:30 am–9:30 am	Membership	Pool & Rec
9:30 am–10:00 am	Break	
10:00 am–11:00 am	Marketing	Safety
11:00 am–12:00 pm	CQ	—
12:00 pm–1:00 pm	Lunch	—
1:00 pm–3:30 pm	Board	—

MARCH 26-30, 2017

The ACI Concrete Convention and Exposition

Theme: "Driving Concrete Technology"

Marriott Detroit at the Renaissance Center

Detroit, MI

www.concrete.org

Shotcrete Calendar

JUNE 4-8, 2017

The International Bridge Conference

Gaylord National Resort and Convention Center
National Harbor, MD

www.miningamerica.org

JUNE 11-14, 2017

ASTM International Committee C09, Concrete and Concrete Aggregates

Sheraton Toronto
Toronto, ON, Canada

www.astm.org

OCTOBER 14, 2017

ASA Fall 2017 Committee Meetings

Disneyland Hotel
Anaheim, CA

www.shotcrete.org

OCTOBER 15-19, 2017

The ACI Concrete Convention and Exposition

Theme: "Making Connections"

Disneyland Hotel

Anaheim, CA

www.concrete.org

DECEMBER 3-6, 2017

ASTM International Committee C09, Concrete and Concrete Aggregates

Sheraton New Orleans

New Orleans, LA

www.astm.org

See this full list online with active links to each event: visit www.shotcrete.org and click on the Calendar link under the News & Events tab.

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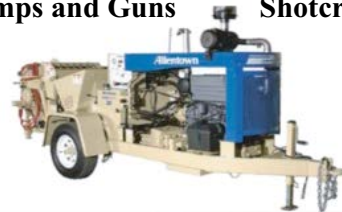
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ASA at 2017 WOC

ASA will again have a host of events at World of Concrete 2017 this January at the Las Vegas Convention



Center! Check out our “World of Concrete” page under the “News & Events” tab at www.shotcrete.org for details. Highlights include:

- **ASA Board and General Membership Meetings:** Monday, January 16, 2017, 9:00 a.m.–11:30 a.m. All are welcome. Come learn how you can contribute to the Association in promoting the safe and beneficial use of shotcrete in the industry!
- **ASA Shotcrete Nozzleman Education Class:** Tuesday, January 17, 2017, 9:00 a.m.–4:00 p.m. This year, Wet-Mix (Henderson, NV) AND Dry-Mix (Bakersfield, CA) Certifications are also available at local contractor yards. See website for details.
- **ASA Annual Outstanding Shotcrete Project Awards Banquet:** Tuesday, January 17, 2017, Vdara Hotel & Spa, 6:00 p.m.–10:00 p.m. Always an industry highlight!
- **90-minute Seminar:** Shotcrete Technology—Advances, Research and Challenges in Using Shotcrete: Wednesday, January 18, 2017, 8:30 a.m.–10:00 a.m. Interested in learning more about how and where shotcrete can benefit your projects? This is the seminar for you!
- **CICL Application of Shotcrete Course** (offered in Spanish): Wednesday, January 18, 2017, 9:00 a.m.–1:00 p.m. First-time opportunity to participate in a shotcrete class conducted fully in Spanish! (Please note: this class DOES NOT substitute for the required ASA Education to pursue certification.) Curso capacitación teórica para mejorar las habilidades del lanzador en el lugar de trabajo para mejorar la calidad del concreto lanzado colocado. Al finalizar el curso, el participante obtendrá los conocimientos mínimos de la tecnología del concreto y concreto lanzado, incluyendo las medidas de seguridad y salud, a través de la revisión documental del concreto lanzado.

Visit ASA at Booth #S10839! Use ASA’s source code: **A17** for discounted exhibit-only passes.

ASA Twelfth Annual Outstanding Shotcrete Project Awards Banquet

Tuesday, January 17, 2017 | Vdara Hotel & Spa | Las Vegas, NV

Every year, industry leaders gather to celebrate the outstanding work demonstrated in the shotcrete industry at ASA’s Outstanding Shotcrete Project Awards Banquet. Come meet new friends and old acquaintances at this year’s celebration—we have a great lineup of projects to award in January!

Early-bird registration for the Banquet ends December 29, 2016: www.shotcrete.org/pages/secured/ASABanquetRegform.aspx.

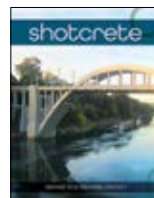


New Shotcrete Brochures

ASA is pleased to release a new series of shotcrete brochures, aimed to meet the needs of specific market segments:

- Architectural
- Ground Support
- New Structures
- Pools, Water Features, and Skateparks
- Repair and Rehabilitation

These four-page brochures are now much more affordable for you to use in your marketing efforts to promote shotcrete! Sold in bundles of 25, they can be purchased directly from the online ASA Bookstore: www.shotcrete.org/BookstoreNet/default.aspx.





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2017 Shotcrete Magazine Media Kit Now Available

Shotcrete magazine will see a facelift in 2017 in ASA’s continued rebranding efforts. This combination of exceptional access at affordable rates provides the shotcrete industry with an important and useful tool for promoting your products and services.

Themes for 2017 include:

- Winter: Outstanding Shotcrete Project Awards;



Association News

- Spring: Tunnels/Mining;
- Summer: Corrosion Protection; and
- Fall: Pools.

For more information, visit www.shotcrete.org/media/pdf/ASAMediaKit.pdf or call (248) 848-3780.

ASA to Offer Complimentary Shotcrete Seminars for Academic Institutions

In an ongoing effort to most effectively reach the next generation of engineers, architects, and designers with the flexibility and options shotcrete application provides, the American Shotcrete Association will offer complimentary presentations to universities in the United States and Canada. If your university is interested, please e-mail info@shotcrete.org for more information.

New York Build—March 15-16, 2017

New York Build is one of the leading construction exhibitions to focus exclusively on construction opportunities in and around New York City, NY.

New York Build 2017 is the ideal opportunity for your organization to hear about all the latest construction projects in the city, as well as enjoy the opportunity to network with NYC's leading contractors, real estate developers, brokers, architects, government, and other construction industry professionals.

ASA will be presenting an AIA CES seminar at the Infrastructure Summit featured on Day 1 of the Expo. See the ASA website Calendar for more details.

ASA is an event partner and is able to offer exhibitors a 10%

discount. Contact info@shotcrete.org for details. Sign up for free registration: <http://newyorkbuildexpo.com>.

ASA Spring 2017 Committee Meetings

Saturday, March 25, 2017 | Save the Date!

ASA will be hosting our spring meetings at the home office in Farmington Hills, MI! Stay tuned for details. With The ACI Concrete Convention and Exposition located in downtown Detroit, MI, ASA looks forward to welcoming ASA members



to the home office for our 2017 spring meetings. The optional Spring Committee Dinner will take place the evening before (Friday, March 24) to accommodate travel into Detroit on Saturday evening for those who will be attending ACI meetings on Sunday, March 26; please visit the ASA website Calendar for the ACI Committee Schedule. As always, meetings are open to all; however, for this meeting, we would need an RSVP e-mailed to info@shotcrete.org to confirm your attendance.

Schedule of ASA Committee Meetings

Time	Multipurpose Room	Meeting Room A
7:30 am–8:30 am	Education	Underground
8:30 am–9:30 am	Membership	Pool & Rec
9:30 am–10:00 am	Break	
10:00 am–11:00 am	Marketing	Safety
11:00 am–12:00 pm	Contractor Qualification	—
12:00 pm–1:00 pm	Lunch	—
1:00 pm–3:30 pm	Board	—

Shotcrete OnLine
MAGAZINE



All ASA members and subscribers have access to the electronic version of *Shotcrete* magazine. A link to this e-magazine is sent as an item in the "What's in the Mix" e-newsletter. To ensure that you receive access to every issue of the electronic version of the magazine, send your e-mail information to info@shotcrete.org.

Atlas Copco Construction Names a New President to Lead North American Growth

Atlas Copco Construction has appointed Scott Carnell as President of its U.S. division. Carnell replaces Erik Sparby, who has accepted the role of General Manager, Customer Center CR Greater China. Carnell will lead the company in growing each of its product lines, including construction tools, portable energy, and road construction equipment within the contractor, dealer, and rental industries across North America.

"Atlas Copco has always been committed to the success of this industry, which is also something I'm passionate about," Carnell said. "I look forward to driving that commitment and building our support network in North America even further."

Carnell brings more than 32 years of industry experience to his role, the last 10 of which have been with Atlas Copco.



Scott Carnell

Carnell served as the Business Line Manager for the Atlas Copco portable energy business area, where he led the market expansion of the air compressor and generator lines. Just prior to his new role, Carnell was the President of Atlas Copco Rental in North America, based in LaPorte, TX.

Carnell said he looks forward to renewing relationships with the construction industry, including dealers and rental centers as well as with the Atlas Copco support team. His depth of knowledge of the company and product lines will provide a seamless transition and allow him to ramp up efforts quickly while his fresh perspective will help drive growth even faster.

"It's not just about me or Atlas Copco," Carnell said. "It's about the customers and what they need, Atlas Copco and the equipment it can provide them, and our strong support team. I want to help bring that all together."

Atlas Copco Appoints Cheney, Blais to New Leadership Roles

Atlas Copco Mining, Rock Excavation and Construction, has appointed Shawn Cheney to the position of Business Line Manager – Rock Drilling Tools, and Jason Blais to Cheney's former position as Vice President of Specialty Stores.

Torbjorn Redaelli, President and General Manager of Atlas Copco Mining, Rock Excavation and Construction LLC, said, "Shawn's industry experience with distributors, business lines, and store channel sales, coupled with his strong results-driven approach, makes Shawn well-suited for this position."

Cheney joined Atlas Copco as the Vice President of its Road Construction Equipment company in 2010 after holding a variety of management positions over 13 years for other companies. Cheney earned his Mechanical Engineering degree from the Colorado School of Mines, Golden, CO, and his MBA from Indiana University, Bloomington, IN.

Redaelli said, "The vast experience Jason has held in several positions during his career with Atlas Copco, not to mention his own experience as an end-user in the industry, gives him a unique skillset and the overall expertise in the mining and construction business to ensure his success in his new position."

After joining Atlas Copco Construction and Mining as a Service Technician and Sales Support Representative in 1997, Blais assumed the position of Technical Product Specialist and Service Coordinator, becoming a Demo and Training Specialist in 1999. In 2001, Blais became an Area Sales Manager until his promotion to Store Manager of the Abingdon, MD, Customer Center in 2007. Blais was also Product Manager for down-the-hole drilling products and most recently Regional Manager for Atlas Copco stores in the Southeast United States region since 2012.



Shawn Cheney



Jason Blais



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Redaelli said, "Jason's industry expertise and the emphasis on customer satisfaction he has consistently exhibited throughout his 20-year career in sales and support roles combine to make him the perfect choice for this assignment."

Hayward Baker Expands its Regional Presence with New Office Facilities in New Orleans

Hayward Baker Inc., North America's leader in geotechnical construction, announces the opening of a new office location in New Orleans, LA. The new office will support customers and projects along the Gulf Coast. As an extension of the Houston office, the New Orleans office is spearheaded by recent hire Christopher Rogers, PE, Project Manager, with oversight from Tyson Deklavs, Area Manager.

Rogers is a graduate of Mississippi State University, Starkville, MS, where he received



Christopher Rogers

his BS in civil and environmental engineering. He is a licensed engineer in Mississippi and Louisiana. Rogers has over 10 years of diverse experience in quality control, design-build, and project management. Prior to joining Hayward Baker, Rogers worked for a general contractor in Louisiana as the Senior Quality Control Manager, as well as a Field Project Manager. He also has spent part of his career as a Geotechnical Consultant.

According to Deklavs, the opening of the New Orleans office represents a commitment to closer collaboration with public, commercial, and industrial Gulf Coast clients. This market includes a diverse group of general contractors, geotechnical consultants, developers, and industrial owners.

"The Gulf Coast is an exciting market for Hayward Baker. The soils are well-suited for our ground engineering techniques. By combining our experience and existing client base with Chris's local presence and expertise, we are now situated to capitalize on the strong growth potential in this market. We are excited to welcome Chris to the Hayward Baker team," he stated.

Recent local projects illustrate the wide range of foundation design-build services Hayward Baker already performs

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Upcoming Themes...

Spring 2017
Tunnels/Mining

Summer 2017
Cathodic Protection

...as well as Shotcrete Corner,
Technical Tip, and more.

For more information, contact ASA:

Phone: 248-848-3780

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510.568.1601 Fax

Pacific Northwest Office:
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Seattle, WA 98108
206.767.2445 Office
206.767.3225 Fax

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212.227.8177 Fax

www.shotcrete.com

in the region. These include numerous deep soil mixing and jet grouting projects for the United States Army Corps of Engineers and industrial clients.

Hayward Baker used several ground modification techniques at the New Orleans Veterans Affairs Hospital. Prefabricated vertical wick drains were used to expedite consolidation settlement, reducing the down drag on foundation piles. The project also included three deep excavations using sheet piles and jet grouting. Micropiles were used to support a new pile cap and column inside the historic Dixie Brewery Building, which is now the Veterans Affairs New Orleans Dixie Research Facility.

The New Orleans office of Hayward Baker is located at 839 St. Charles Avenue, Suite 100, New Orleans, LA 70130. For more information on the services offered by the office, contact Christopher Rogers, PE, at (504) 321-2420. For a complete listing of Hayward Baker's 33 regional and local offices in North America, visit www.haywardbaker.com/locations.

Hayward Baker (www.haywardbaker.com) is North America's leader in geotechnical construction, annually ranked by *Engineering News-Record (ENR)* magazine No. 1 in foundation construction. With a 60-year record of experi-

ence, Hayward Baker offers geotechnical construction technologies through a network of more than 30 company-owned offices and equipment yards across the continent. Project applications include foundation support, settlement control, site improvement, slope stabilization, underpinning, excavation shoring, earth retention, seismic/liquefaction mitigation, groundwater control, and environmental remediation.

Hayward Baker Inc. is part of the Keller Group of companies, a multinational organization providing geotechnical construction services throughout the world.

Putzmeister America, Inc., Announces Peter Mendel as President and Chief Executive Officer

Putzmeister

Putzmeister America, Inc., announces Peter Mendel as the successor to Dave Adams, President and Chief Executive Officer. In his new role, Mendel will assume full responsibility for overseeing Putzmeister America and its subsidiaries located in California, Houston, and Mexico.



Peter Mendel

Adams' career with Putzmeister spans 20 years, starting with the company as its Vice President of Engineering, and his past 16 years as President and CEO. Under Adams' leadership, Putzmeister America achieved significant success, including outstanding business growth, greatly expanded facilities in Sturtevant, several innovative product line additions, and new business developments in several countries. These accomplishments have resulted in Putzmeister as market leaders in North and South America.



Dave Adams

Adams remains on the Putzmeister America Board of Directors, and he will also take on a significant role related to strategic business and product development. His input and presence within the industry will remain evident at trade shows and association events. He can be reached at his same contact phone numbers at the Wisconsin Putzmeister locations as well as his e-mail at adamsd@putzam.com.

Mendel joined the Putzmeister team in March 2015 as Senior Vice President and Chief Operating Officer, and he quickly learned the business and operations related to concrete and material placing equipment. Prior to Putzmeister, his experience included more than 20 years in operations, engineering, manufacturing, and quality while involved with industries, predominantly automotive, located in the United States, Germany, and Mexico.

In his new role, Mendel will report to Dr. Gerald Karch, CEO of Putzmeister Holding GmbH (Germany), and he will remain based at Putzmeister America's headquarters in Sturtevant, WI. He can be reached at mendelp@putzam.com.



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Airplaco Equipment Company Announces New Vice President of Sales

Airplaco Equipment Company is pleased to announce the promotion of Ken Segerberg to Vice President of Sales.

Segerberg has been with Airplaco for over 10 years as Director of Sales and during this time has been a critical contributor to the continued growth and success of Airplaco. Under his leadership, the Airplaco Sales Team continues to deliver a superior customer experience by focusing on customer training, technical support, and overall customer service.

More information about Airplaco's equipment can be viewed on its website: www.airplaco.com.



Ken Segerberg

Airplaco Equipment Company Furthers International Expansion

Airplaco Equipment Company has established a partnership with Ecotech Emirates (www.ecotecemirates.com) to represent Airplaco products throughout the UAE and the Middle East. Pratish Thomas will serve the role as Independent Sales Representative from Ecotech's office in UAE. Pratish has over 10 years of experience in distribution of industrial products for various applications.

"We are confident that Ecotech will be a vigilant partner for Airplaco in the region," said Ken Segerberg, Vice President of Sales. "They will work closely with Airplaco to service existing accounts while striving to expand market share throughout the gulf countries for Airplaco's shotcrete and grouting equipment."

Airplaco is an American manufacturer of construction equipment used in various applications throughout the world. Airplaco offers masonry grout pumps, gunite and shotcrete machines, concrete leveling pumps, and void fill pumps as well as all of the parts, accessories, and finishing tools needed for any job. For over 60 years, Airplaco has built a reputation for quality equipment and superior customer service. They stand behind their equipment and are committed to understanding the demands of their customers.

More information about Airplaco's equipment can be viewed on its website: www.airplaco.com.

AIRPLACO®

Chicago Expansion Bolt Celebrates Its 100th Year of Business

Chicago Expansion Bolt is celebrating its 100th year of business. Chicago Expansion Bolt was founded by Ralph S. Pierce in 1916. Pierce is the original patent holder and his company remained in his family until Joseph Gayton purchased the company in 1980. Gayton's son and daughter-in-law purchased the company from him in 2006. This husband and wife team are also celebrating their 10-year anniversary of owning and operating this company.



The Chicago Expansion Bolt is a fastening device that anchors things such as stadium seats and church pews to concrete. Chicago Expansion Bolt manufactures these devices and other products such as the Tumble Toggle bolts and J Hook Bolts in its Schiller Park, IL, facility. The company is very proud of its American-made products.

WHAT HAVE YOU BEEN DOING? CAN'T GET READY MIX TO YOUR JOB?

Tunnels, outdoors, remote locations by rail or barge.

Mix it properly before you shoot!

Have air and moisture content consistently, yard after yard.

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GCP Applied Technologies Introduces TYTRO® Admixture System for Shotcrete Applications

GCP Applied Technologies Inc. has introduced the TYTRO® Shotcrete System, a complete state-of-the-art admixture solution that makes shotcrete for underground construction better, faster, and less expensive than conventional systems available today. The TYTRO System includes a nanotechnology-based rheology control agent, patented macro synthetic fibers, and a number of other newly developed admixtures that enhance productivity of the spraying operation and material performance.

“Our TYTRO Shotcrete System provides improved agility and additional capabilities that applicators and global contractors have been demanding for decades,” said Adam Grose, President, Specialty Construction Chemicals, GCP Applied Technologies.

The TYTRO Shotcrete System provides underground construction professionals with the capability to reduce operating costs and minimize excavation downtime without sacrificing performance or relaxing safety standards. The TYTRO Shotcrete System provides faster early strength and enhanced bonding-to-rock with an increased one-pass thickness buildup. The system also minimizes rebound during spraying.

Main advantages* provided by the TYTRO Shotcrete System compared to conventional mixtures include:

- **Up to 10% lower installed cost** achieved through mixture optimization, waste minimization, and shorter cycle times;
- **Rebound rates reduced to 5 to 8%;**
- **Faster re-entry times** due to more rapid early-age strength development at equal accelerator dosage rate;
- **Superior bond-to-rock** and adhesion between layers, providing greater thickness in one pass; and
- **More robust and dosage-efficient system.**

“Our technical specialists have analyzed the unique challenges of underground construction projects to create customized mixture designs, delivering the most optimized and cost-efficient concrete mixture for each project. We also support our customers with world-class site support and training,” said Grose.

The TYTRO Shotcrete System includes the following products:

- **TYTRO WR:** High-range water-reducing admixtures for shotcrete that provide superior flow, prolonged slump life, and excellent plasticity, maximizing strength performance by allowing a lower water-cementitious materials ratio (w/cm);
- **TYTRO HC:** Cement hydration control admixture, extending the working life of shotcrete up to 72 hours;



- **TYTRO RC:** Innovative pozzolan-based rheology control admixture that is designed to reduce installed material cost when used as a replacement for silica fume or other cementitious materials. It provides faster early strength, superior bond-to-rock, enhanced sprayability, lower rebound, and reduced cycle times;
- **TYTRO SA:** Latest generation of high-performance, alkali-free set accelerators, specifically formulated to provide high early strength at low dosage rates and improve productivity by shortening the time of setting without compromising long-term strength and durability;
- **STRUX® BT:** Macrofibers featuring a patented design developed for underground shotcrete applications and offering superior flexural toughness and post-crack energy absorption;
- **TYTRO AE:** Air-entraining admixture for use in shotcrete mixtures to protect against damage from freezing-and-thawing cycles; and
- **TYTRO RM:** Rheology-modifying and mixture-enhancing admixtures formulated to improve the pumpability and sprayability of the shotcrete mixture.

GCP's complete portfolio of solutions for the mining and infrastructure tunneling industries includes admixtures for shotcrete and concrete, proprietary fiber reinforcement systems, injection technologies for ground support, and waterproofing systems for shotcrete. The company combines its technical expertise in shotcrete mixture design optimization, on-site monitoring systems, and ground control technologies to fit to every project's unique needs. GCP's technical specialists work to provide solutions to overcome project geotechnical challenges around the world.

Through applied knowledge and service excellence, GCP Applied Technologies provides premier specialty construction chemicals and specialty building materials for many of the world's most renowned structures, and packaging technologies for the best-known consumer brands, delivering results for all its customers. With customers in 110 countries, operations on six continents, and a team of approximately 2850 employees, GCP Applied Technologies had a 2015 net sales of US \$1.4 billion. Formerly part of the W.R. Grace & Co. Group, GCP Applied Technologies Inc. became a NYSE-listed company (GCP) in February 2016, headquartered in Cambridge, MA, USA. More information is available at GCPAT.com.



*Referenced results are based on internal and external test data. Results may vary due to temperature conditions, mixture design, cementitious materials content, and aggregate gradations.

New Products & Processes

New Schwing S 38 SX Has Unique Five-Section Boom

The new S 38 SX from Schwing combines a tight (22 ft 10 in. [7 m]) front outrigger spread



**SCHWING
AMERICA INC.**

with a lightweight (Federal Bridge Legal) design and a five-section boom with more articulation than any other boom style. The new model is available in a three-axle configuration with cab-over truck or as a four-axle version with conventional truck to meet federal bridge laws. "This is a concrete pump that defines versatility for concrete contractors and pumpers," states Tom O'Malley, Senior Vice-President of Sales and Marketing for the manufacturer. "The new boom design hyperextends at every section to exceed the capabilities of Roll and Fold and Z Booms." Key features of this one-of-a-kind Roll and Fold boom are that all of the articulation is on the working side of the boom for faster deployment and it has the ability to snake the end hose-deep into decks. The boom provides 106 ft 11 in. (32.6 m) of horizontal and 122 ft 4 in. (37.3 m) of vertical reach.

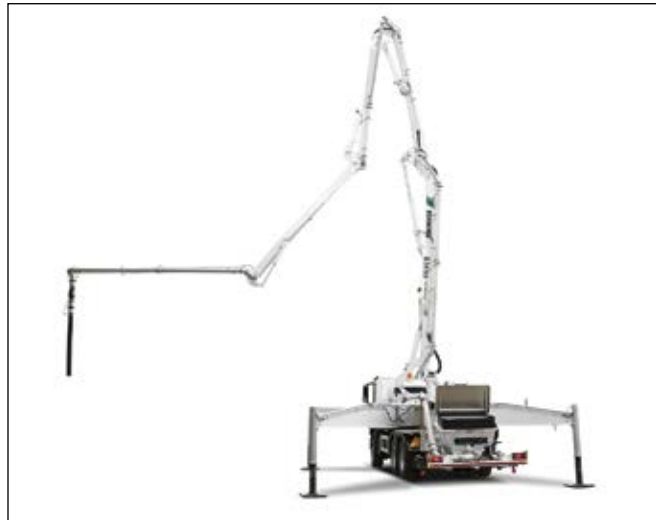
Front outriggers are the exclusive Super X style that telescope out and around jobsite obstructions. For tight setups, the outriggers can be deployed on one side only with the standard EASy system that narrows the footprint and provides up to 180 degrees of boom rotation on the pour side of the pump. The system is integrated into Schwing's VECTOR Controls that monitor and ensure the safety of the pump and its operator. The Vector system also provides proportional radio remote control of the boom function and communicates with the operator to stay fully informed of the pump's status even when hundreds of feet from the pump.

Concrete pumping is provided by the proven Schwing open-loop, twin-cylinder hydraulic pump that is offered in two sizes on the S 38 SX with output to 213 yd³ (163 m³) per hour. Both pump kits use the exclusive Rock Valve capable of pumping the harshest mixtures while cleaning up with less water than other brands. The Schwing design with long-stroke and large-diameter pumping cylinders reduces wear by achieving pumping volume with fewer strokes per minute.

"This is the high-utilization pump that will be requested daily because of this unique boom," explains O'Malley. "It has the ability to place concrete where

other booms cannot while providing fast setup, maneuverability on-site, and proven Schwing reliability."

For more information, visit www.schwing.com or call 1-888-SCHWING.



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Basalite Concrete Products ULC



Basalite Concrete Products ULC, acquired by Pacific Coast Building Products in 1979, has become one of the largest manufacturers and suppliers of concrete products in western North America. Product lines include a full range of packaged dry-mix concrete, shotcrete, anchor grout, cement, mortars, and bridge overlays available in custom mixtures and packaging. Also available are a variety of structural concrete masonry unit (CMU) block, green wall systems, retaining walls, and revetment products (ACB). Incorporating seven manufacturing locations, Basalite has multiple locations in Canada and along the western United States to serve a variety of customers.

Shotcrete

Basalite offers our proprietary Microsil Shotcrete, which is a pre-blended dry shotcrete containing silica fume and other carefully selected components. Microsil Shotcrete has greatly



Basalite Microsil Shotcrete applied for slope stabilization, as shot by LRutt Contracting

enhanced shooting characteristics and physical properties. Basalite shotcrete has been used in a variety of commercial and heavy civil projects ranging from overhead parking lot repairs to dams and slope stabilization.

Basalite also offers custom production services and can produce any mixture design required by engineers in small and bulk packaging.

Dry Mix

Basalite offers an extensive line of packaged concrete products designed for contractors, industry professionals, and homeowners. From basic sands, concrete and mortar mixtures, to specialized shotcrete, grout, and patching solutions, Basalite manufactures to exceed the highest standards detailed by both CSA and ASTM International.

Dry-mix product lines include various concrete mixtures, concrete repair products, cleaners/primers/sealers, grouts, mortar, and cement blends. Our products have been used in many projects from bridges and roadways to commercial and residential buildings.

Often engineers will call for custom products, and Basalite specializes on producing custom mixtures with custom packaging. With their in-house lab, Basalite can conduct research and development (R&D) services alongside engineers and designers to find a custom product suitable



Basalite Microsil Anchor Grout used for soil anchors

Corporate Member Profile



Nighttime shotcrete operations for slope stabilization

for any application. Basalite can also custom-package any product from small bags to industrial size bulk bags.

Concrete Masonry Units

The use of Basalite CMUs has grown rapidly in demand over the past couple of decades. This has been due to not only the building boom in northern California but also as a result of advances in building design and changes in architectural preference. Basalite Concrete Products manufactures hundreds of types and styles of concrete structural block.

Basalite presents a complete offering of custom colors, shapes, and sizes in most product lines and often works with architects to create effects that showcase the building's design. The full line and custom options are available to builders and developers. Blocks range from regular to colored, split face, and ground face profiles for architectural solutions. They work together with designers to make sure every detail is correct for the intended application.

Segmental Retaining Wall

Basalite produces multiple products for a variety of wall applications, ranging from simple landscape projects to critical structures. Basalite also offers design services and can assist in any part of the design process.

They produce several types of retaining and landscape walls, available in various colors. From freestanding walls to retaining walls, Basalite offers many options, which will create stunning retaining and terraced walls. Basalite retaining wall has been used from backyard creations to exceptionally large commercial applications.

One-Stop Concrete Shop

Basalite products are available to end users through an array of distributors, but they also service contractors and industrial clients directly. They are your one-stop concrete shop! From design and engineering to R&D and manufacturing, an array of services and products are offered. Located in British Columbia, Alberta, California, Colorado, Idaho, Nevada, and Washington, they can service any location across North America. Contact them to discuss your concrete needs today.

Basalite Concrete Products – Vancouver ULC

8650 130th Street
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Fax: (604) 599-5972
Website: www.basalite.ca
E-mail: james.marifosque@paccoast.com

New ASA Members

CORPORATE MEMBERS

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asoleimani@limengroup.com
Primary Contact: Amir Soleimani

Mid-West Gunite, LP

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midwestgunite.jhyp@gmail.com
Primary Contact: Horacio Yanez

NMN Construction

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ron.federico@nmnconstruction.com
Primary Contact: Rod Federico

Subsurface Construction Company

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www.subsurfaceconstruction.com
alex@subsurfaceconstruction.com
Primary Contact: Alex Smith

Tri-State Gunite LP

Sloatsburg, NY
pablotristate@yahoo.com
Primary Contact: Pablo Yanez

Westport Pools

St. Louis, MO
www.westportpools.com
rcasserly@westportpools.com
Primary Contact: Ryan Casserly

CORPORATE ADDITIONAL INDIVIDUALS

Tim Badilla

Restek Inc.
Manchaca, TX

Carl Baur

Minova Global
Georgetown, KY

John Gothard

National Gunite
Johnstown, PA

James Grayson

Kenny Construction
Northbrook, IL

Timothy P. Martin

National Gunite
Johnstown, PA

Joshua Monroe

GeoStabilization International
Grand Junction, CO

Paul Nikonow

National Gunite
Johnstown, PA

Jake T. Wiseman

CCS Group LLC
Saint Clair, MO

INDIVIDUALS

George Frederick

Vue Custom Pools, Inc.
Greensboro, NC

Gregory S. McIntosh

GSM Builders, LLC
Fort Lauderdale, FL

New ASA Members

STUDENTS

Joseph Dylan Martinez
Cal Poly Pomona
Cypress, CA

Bradley Meyer
Golden, CO

Mehdi Khanzadeh Moradillo
Oklahoma State University
Stillwater, OK

Tom Pochatko
University Park, PA

Fnu Ritika
Austin, TX

Pierre Siccardi
Laval University
Quebec, QC, Canada

John T. Valcheff
National Gunitex
Johnstown, PA

Aram Meharena Weldu
Eritrea Institute of Technology
Abardae, Mai Nefhi, Eritrea, Africa

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NEED A SHOTCRETE CONTRACTOR OR CONSULTANT FOR A SPECIFIC PROJECT?



SUBMIT YOUR PROJECT FOR A BID REQUEST

The American Shotcrete Association has created a free online tool to allow owners and specifiers the opportunity to distribute their bid request to all ASA Corporate Members in one easy form!

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outstanding Corporate Members today by visiting:

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2016 Buyers Guide

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The following list of ASA Corporate Members is current as of October 25, 2016. For a current listing, including the ability to search by seven major specialties (as well as over 100 subspecialties) and states/provinces served, visit the online ASA Buyers Guide at www.Shotcrete.org/BuyersGuide.

Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Mort	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Abbott Shoring & Foundations Ltd PO Box 1040 Coquitlam, BC V3J 6Z4, Canada	Website: www.abbottshoring.com Contact: Sylvia Bourgeois Phone: 604-520-5990 E-mail: sylvia@abbottshoring.com	•			•			
Active Minerals International, LLC 34 Loveton Circle, Suite 100 Sparks, MD 21152	Website: www.acti-gel.com Contact: Joey Bell Phone: 410-512-4120 E-mail: r.bell@activeminerals.com	•	•					
Advanced Shoring & Underpinning Inc. 700 S Fulton Street Salt Lake City, UT 84104	Website: www.advancedshoring.com Contact: Per-Ole Danfors Phone: 801-908-7664 E-mail: pdanfors@advancedshoring.com				•			
Airplaco Equipment Company 4027 Eastern Ave Cincinnati, OH 45226-1747	Website: www.airplaco.com Contact: Tom Norman Phone: 513-321-4511 E-mail: sales@airplaco.com					•		
AMEC Foster Wheeler 4445 Lougheed Hwy, Ste 600 Burnaby, BC V5C 0E4, Canada	Website: www.amecfw.com Contact: John Laxdal, PE Phone: 604-294-3811 E-mail: john.laxdal@amec.com			•				
American Concrete Restorations Inc. 11S375 Jeans Rd Lemont, IL 60439-8839	Website: www.americanconcreterestorations.com Contact: Cathy Burkert Phone: 630-887-0670 E-mail: cathy@americanconcreterestorations.com				•			
American Standard Conc Pumping Hawaii Inc. 94-400 Koaki St Waipahu, HI 96797-2874	Website: www.ascphi.com Contact: Gregory L Perrin Phone: 808-479-7867 E-mail: gperrin@ascphi.com			•	•	•		
Arco Gunit, Inc. 1448 N Glassell St Orange, CA 92867-3612	Website: http://arcogunit.com Contact: Tammy Counoupas Phone: 714-771-6022 E-mail: tammy.c@arcogunit.com				•			
Arnold Brothers Inc. 2437 SW Pine Island Rd Cape Coral, FL 33991	Website: www.arnoldbrothers.net Contact: Steve Arnold Phone: 239-633-9970 E-mail: keith@arnoldbrothers.net		•	•	•		•	•
Associated Pool Builders Inc. 2121 Lovett Ave Bismarck, ND 58504	Website: www.associatedpoolbuilders.com Contact: Jeni Bailey Phone: 701-258-6012 E-mail: jenniferb@associatedpoolbuilders.com				•			
Atlantic Underground Services Ltd. 425 Pine Glen Rd Riverview, NB E1B 4J8, Canada	Website: www.ausltd.com Contact: Terry Keiver Phone: 506-387-8160 E-mail: info@ausltd.com				•			

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Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Atlantis Marine Habitats, LLC 5310 E Plantation Oaks Arcola, TX 77583	Website: www.atlasmarinehabitats.com Contact: Thomas Hilton Phone: 713-530-2267 E-mail: hilton@rt-nav.com							
Atlas Copco Construction Equipment 11313 Steele Creek Rd Charlotte, NC 28273	Website: http://atlascoopco.us Contact: Kell Cleeland Phone: 704-437-8178 E-mail: kell.cleeland@us.atlascoopco.com					•		
Azteca Gunitite 6626 Flintlock Rd Houston, TX 77040-4319	Website: www.aztecagunitite.com Contact: Ozzie Martinez Phone: 713-462-5566 E-mail: info@aztecagunitite.com				•			
Basalite Concrete Products - Vancouver ULC 8650 130th Street Vancouver, BC V3W 1G1, Canada	Website: www.basalitedrymix.com Contact: Dennis Ceolin Phone: 604-501-7941 E-mail: dennis.ceolin@paccoast.com	•	•	•			•	•
BASF Admixtures Inc 23700 Chagrin Blvd Cleveland, OH 44122-5506	Website: www.basf-admixtures.com Contact: Jim Lindsay Phone: 216-839-7500 E-mail: jim.lindsay@basf.com	•	•					
Bekaert-Maccaferri Underground Solutions Skyline 40 Korte Keppestraat 21/02 Erembodegem-Aalst 9320, Belgium	Website: www.bm-underground.com Contact: William Geers, PE Phone: 011-8133137759 E-mail: bill.geers@bm-underground.com			•	•	•	•	•
BelPacific Excavating & Shoring Ltd. 3183 Norland Ave Burnaby, BC V5B 3A9, Canada	Website: www.belpacific.com Contact: Ratib Baqi Phone: 604-205-7825 E-mail: ratib.baqi@belpacific.com			•	•			
Berkel & Company Contractors Inc. 7300 Marks Ln Austell, GA 30168	Website: http://berkelapg.com Contact: Mark Tominey Phone: 770-941-5100 E-mail: mtominey@berkelapg.com							
The Blanchard Group 2380 Route 315 Dunlop, NB E8K 2J6, Canada	Website: www.blanchardgroup.ca Contact: Rene Blanchard Phone: 506-725-2132 E-mail: rene@blanchardgroup.ca							•
Blastcrete Equipment Company PO Box 1964 Anniston, AL 36202-1964	Website: www.blastcrete.com Contact: Jim Farrell Phone: 256-235-2700 E-mail: jim@blastcrete.com			•		•		
Boulderscape Inc. 27134 B Paseo Espada, #223 San Juan Capistrano, CA 92675	Website: www.boulderscape.com Contact: Mark Allen Phone: 949-661-5087 E-mail: steve@boulderscape.com				•			
Brayman Construction Corporation 1000 John Roebing Way Saxonburg, PA 16056-9778	Website: www.brayman.com Contact: Brian Hawk Phone: 724-443-1533 E-mail: b_hawk@brayman.com				•			
Brierley Associates 990 S Broadway, Ste 222 Denver, CO 80209	Website: www.brierleyassociates.com Contact: Bill Zietlow Phone: 303-703-1405 E-mail: bzietlow@brierleyassociates.com			•				
Buesing Corp. 3045 S 7th St Phoenix, AZ 85040-1170	Website: www.buesingcorp.com Contact: Kevin Somerville Phone: 602-233-3339 E-mail: ksomerville@buesingcorp.com			•	•			

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Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Bulley & Andrews Concrete Restoration 1755 W Armitage Ave Chicago, IL 60622-1163	Website: www.bacrllc.com Contact: Donald Redar Phone: 773-645-2061 E-mail: tabbott@bulley.com				•			
BVR Construction Company Inc. 8 King Road Churchville, NY 14428	Website: www.bvrconstruction.com Contact: Chip Stephenson Phone: 585-458-9750 E-mail: cstephenson@bvrconstruction.com				•			•
Cal Gunitite 12640 Jomani Dr Bakersfield, CA 93312	Contact: Ann Sulla Campbell Phone: 661-589-0556 E-mail: calgunitite@yahoo.com				•			
California Skateparks 273 N Benson Ave Upland, CA 91786-5614	Website: www.californiaskateparks.com Contact: Joseph M. Ciaqlia Jr. Phone: 909-949-1601 E-mail: info@californiaskateparks.com			•	•			
Canadian Greenfield Technologies Corp. 159, 3953-112 Ave SE Calgary, AB T2C 0J4, Canada	Website: http://canadiangreenfield.com Contact: Mike Pildysh Phone: 403-720-8815 E-mail: mike.pildysh@canadiangreenfield.com	•					•	
CanCrete Equipment Ltd. 6290 Shawson Dr, Unit B Mississauga, ON L5T 1H5, Canada	Website: www.cancreteequipment.ca Contact: Eric Duiker Phone: 416-749-2843 E-mail: marcia@cancreteequipment.ca					•		
Canusa Equipment Ltd 230A Brunette Ave New Westminster, BC V3I 3E3, Canada	Website: www.canusaequipment.com Contact: Kim Fabbro Phone: 604-526-5151 E-mail: info@canusaequipment.com					•		
CCS Group LLC 655 South St, Suite #2 Seward, NE 68434-2439	Website: www.ccsgrouponline.com Contact: Cheyenne Wohlford Phone: 855-752-5047 E-mail: cheyenne@ccsgrouponline.com	•	•	•	•	•	•	•
Cementec Industries Inc. 159-3953 112 Av SE Calgary, AB T2C 0J4, Canada	Website: www.cementec.ca Contact: Arne Owre Phone: 403-720-6699 E-mail: arne.owre@cementec.ca	•	•					
CemenTech Inc. 1700 N 14th St Indiala, IA 50125	Website: www.cementech.com Contact: Mark Rinehart Phone: 800-247-2464 E-mail: ctisalesinfo@cementech.com	•				•		
Cemrock Landscapes Inc. 4790 S Julian Ave Tucson, AZ 85714	Website: www.cemrock.com Contact: Steve Kaza Phone: 520-571-1999 E-mail: skaza@cemrock.com				•			
Chicago Expansion Bolt 9353 Seymour Ave Schiller Park, IL 60176	Website: www.chicagoexpansionbolt.com Contact: Dan Gayton Phone: 847-233-0509 E-mail: sales@chicagoexpansionbolt.com					•		
Classic Tile & Plaster, LLC 746 Gary Dr Byram, MS 39272	Contact: Jorge De Ochoa Jr. Phone: 601-372-0164 E-mail: jd8a@icloud.com		•	•	•		•	•
Coastal Construction Products 3401 Philips Hwy Jacksonville, FL 32207	Website: http://coastalone.com Contact: Yon Hammel Phone: 855-877-3636 E-mail: yhammel@coastalone.com							

Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolan Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Coastal Guniting Construction Company PO Box 977 Cambridge, MD 21613-0977	Website: www.coastalguniting.com Contact: R. Curtis White Jr. Phone: 410-228-8100 E-mail: curt@coastalguniting.com				•			
Concrete Strategies 2199 Innerbelt Business Center Dr Saint Louis, MO 63114-5721	Website: www.concretestrategies.com Contact: Curt Costello Phone: 314-592-2131 E-mail: costelloc@concretestrategies.com			•	•			•
Condon-Johnson & Associates Inc. 480 Roland Way, Ste 200 Oakland, CA 94621	Contact: Hayden Sahw Phone: 206-794-5828 E-mail: hsahw@condon-johnson.com							
Construction Forms, Inc. PO Box 308 Port Washington, WI 53074-0308	Website: www.conforms.com Contact: Andy Kultgen Phone: 800-223-3676 E-mail: andy.kultgen@conforms.com					•		
Contech Services, Inc. PO Box 84886 Seattle, WA 98124-6186	Website: www.contechservices.com Contact: Peter Barlow Phone: 206-763-9877 E-mail: pete@contechserviceswa.com				•			
The Crom Corporation 250 SW 36th Ter Gainesville, FL 32607-2863	Website: www.cromcorp.com Contact: Jeff Malpass Phone: 352-262-4143 E-mail: jdm@cromcorp.com				•			
Cruz Concrete & Guniting Repair Inc. 1405 Winesap Dr Manasquan, NJ 08736-4020	Contact: Warren C. Cruz Phone: 732-223-2206 E-mail: cruzconcrete@gmail.com				•			
C-TEC, Inc. 1928 S Lincoln Ave, Suite 100 York, NE 68467-9467	Website: www.cteconcrete.com Contact: Greg Wurst Phone: 402-362-5951 E-mail: ctec@cteconcrete.com				•			
CTS Cement Manufacturing Corporation 11065 Ktt Ave, Suite A Cypress, CA 90630-5149	Website: www.ctscement.com Contact: Janet Ong Phone: 650-773-4795 E-mail: jong@ctscement.com	•	•					•
Custom-Crete 4433 Terry O Lane Austin, TX 78745	Website: www.custom-crete.com Contact: Bill Heath Phone: 512-443-5787 E-mail: bheath@us-concrete.com				•	•		•
D Construction Inc. 1488 S Broadway Coal City, IL 60416	Website: www.dconstruction.net Contact: Jeff Gillan Phone: 815-634-2555 E-mail: j.gillan@dconstruction.net				•		•	•
Deep Foundations Contractors Inc. 145 Ram Forest Rd Gormley, ON L0H 1G0, Canada	Website: www.deep.ca Contact: Michael Cianchetti Phone: 905-750-5900 E-mail: ktai@deep.ca				•			
Dees-Hennessey Inc. 200 Industrial Rd San Carlos, CA 94070-6257	Website: www.deeshenn.com Contact: Daniel M. Evans Phone: 650-595-8933 E-mail: dhi@dees-hennessey.com				•			
Delta Guniting and Shotcrete 10300 W Charleston Blvd, #13-124 Las Vegas, NV 89135	Contact: Matt Mawhinney Phone: 702-471-1117 E-mail: mmawhinney@delta-gs.com			•				•

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Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Delta Gunit Solano Inc. 1735 Enterprise Dr, Suite #103 Fairfield, CA 94533-6822	Website: www.deltagunitesolano.com Contact: Philip Kassis Phone: 707-425-7293 E-mail: deltasolano@sbcglobal.net				•			•
Delta Industrial Services Inc. PO Box 1109 Delta Junction, AK 99737-1109	Website: www.deltaindustrial.com Contact: Mike Crouch Phone: 907-895-5053 E-mail: mike@deltaindustrial.com							•
Deluxe Shotcrete & Concrete Construction PO Box 385 Santa Rosa, CA 95402-0385	Website: www.deluxeshotcrete.com Contact: Kristen Humphreys Phone: 707-568-1200 E-mail: kristen@deluxeshotcrete.com			•	•			•
Desert Shotcrete Inc. 3230 N Showdown Pl Tucson, AZ 85749	Contact: Joe Schmieder Phone: 520-749-4848 E-mail: joe@desertshotcrete.com				•			
DMB Construction Corp 300 Corporate Plaza, Suite 302B Islandia, NY 11749	Contact: Erin Egan Phone: 631-232-3748 E-mail: erinegan@dmb-construction.com				•			
DN Tanks 11 Teal Road Wakefield, MA 01880	Website: www.dntanks.com Contact: Scott Scorpa Phone: 781-246-1133 E-mail: scott.scorpa@dntanks.com				•			
Dome Technology 4946 North 2900 East Idaho Falls, ID 83401-1337	Website: www.dometech.com Contact: Bryan Butikofer Phone: 208-529-0833 E-mail: bryan.butikofer@dometechnology.com				•			
DOMTEC International LLC 4355 N Haroldsen Dr Idaho Falls, ID 83401-1105	Website: www.domtec.com Contact: Ryan Partridge Phone: 208-522-5520 E-mail: ryan@domtec.com			•	•			
Drake Inc. 1919 Road Q Waco, NE 68460-8826	Website: www.drakeinc.net Contact: David Drake Phone: 402-362-1863 E-mail: davedrake@windstream.net			•	•			
Drakeley Industries LLC 74 Hickory Ln Bethlehem, CT 06751-2308	Website: www.drakeleypools.com Contact: William T. Drakeley Jr. Phone: 860-274-4924 E-mail: bill@drakeleypools.com			•	•			
Drill Tech Drilling & Shoring, Inc. 2200 Wymore Way Antioch, CA 94509-8548	Website: www.drilltechdrilling.com Contact: John Byrne Phone: 925-978-2060 E-mail: john.byrne@drilltechdrilling.com			•	•			
Eastco Shotcrete, LLC 1211 Kennedy Blvd Manville, NJ 08835	Website: www.eastcoastshotcrete.com Contact: Tait Pirkle Phone: 908-526-2777 E-mail: taitpirkle.eastco@gmail.com				•			
Eastern Gunit Company Inc. PO Box 557 Exton, PA 19341-0557	Website: www.easterngunit.com Contact: Thomas F. Lyons Phone: 610-524-5590 E-mail: egunit@easterngunit.com				•			
Elasto Plastic Concrete PO Box 460 Waxhaw, NC 28173-1047	Website: www.elastoplastic.com Contact: Patrick Lewandowski Phone: 704-843-8401 E-mail: plewandowski@elastoplastic.com			•			•	

Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Engineering & Construction Innovations Inc. 7002 6th St N Oakdale, MN 55128-6146	Website: www.eandci.co Contact: Shane McFadden Phone: 651-298-9111 E-mail: shane@eandci.co				•			
Epoxy Design Systems Inc. PO Box 19485 Houston, TX 77224-9485	Website: www.epoxydesign.com Contact: Hank Taylor Phone: 713-461-8733 E-mail: hank@epoxydesign.com			•	•			
Era Valdivia Contractors 11909 South Avenue O Chicago, IL 60617	Website: www.eravaldivia.com Contact: Mike Cash Phone: 773-721-9350 E-mail: mcash@eravaldivia.com				•			
The Euclid Chemical Company 6338 Centerville Road Poplar Grove, IL 61065	Website: www.euclidchemical.com Contact: Heath Morrall Phone: 815-289-4605 E-mail: hmorrall@euclidchemical.com	•	•				•	
Facca Incorporated 2097 County Rd 31 RR 1 Ruscom Station, ON N0R 1R0, Canada	Website: www.facca.com Contact: Don Gardonio Phone: 519-975-0377 E-mail: don@facca.com				•			
Farr Foundation Inc. P.O. Box 957 Rockwall, TX 75087	Website: www.farrfoundation.com Contact: James Steven Farr Phone: 469-478-6242 E-mail: office@farrfoundation.com			•	•			
Fibercon International Inc. 100 S 3rd St Evans City, PA 16033-9264	Website: www.fiberconfiber.com Contact: Nicholas Mitchell Jr. Phone: 724-538-5006 E-mail: nick@fiberconfiber.com				•		•	
Forta Corporation 100 Forta Dr Grove City, PA 16127-6308	Website: www.fortacorp.com Contact: Daniel T. Biddle Phone: 800-245-0306 E-mail: info@fortacorp.com						•	
Freyssinet Inc. 44880 Falcon Place, Suite 100 Sterling, VA 20166	Website: www.freyssinetusa.com Contact: Michael Louis Phone: 703-378-2500 E-mail: michael.louis@freyssinetusa.com				•			
Frontier-Kemper Constructors Inc. 1695 Allen Rd Evansville, IN 47710-3394	Website: www.frontierkemper.com Contact: Jim McMahon Phone: 812-426-2741 E-mail: jmcMahon@frontierkemper.com				•			
G & G Enterprises G.C. 9456 Nottingham El Paso, TX 79907	Website: http://gandgent.com Contact: Juan Garcia Phone: 915-726-8995 E-mail: juan@gandgent.com	•		•	•			
Gall Zeidler Consultants 44345 Premier Plz, Ste 210 Ashburn, VA 20147	Website: www.gzconsultants.com Contact: Anthony Bauer Phone: 703-726-2700 E-mail: abauer@gzconsultants.com			•	•			
Gary Carlson Equipment Co. 1380 West County Road C Roseville, MN 55113	Website: www.garycarlsonequip.com Contact: Gary R. Carlson Phone: 763-792-9123 E-mail: garycarlson@garycarlsonequip.com			•		•		
GCP Applied Technologies 62 Whittemore Ave Cambridge, MA 02140	Website: www.grace.com Contact: Diego Granell Phone: 617-498-4497 E-mail: diego.granell@grace.com	•						

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Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Genesis 3, Inc. 2327 Lionheart Drive Murfreesboro, TN 37130	Website: www.genesis3.com Contact: Dave Peterson Phone: 615-907-1274 E-mail: lisa@genesis3.com			•	•			
GeoBuild, LLC 200 E Campus View Blvd, Ste 200 Columbus, OH 43235	Website: www.geobuild.com Contact: Paul Hale Phone: 866-472-6544 E-mail: phale@geobuild.net			•	•			•
Geostabilization International PO Box 4709 Grand Junction, CO 81502-4709	Website: http://geostabilization.com Contact: Kimberly Ruckman Phone: 970-210-6170 E-mail: kim@gsi.us				•			
Getman Corporation 59750 34th Ave Bangor, MI 49013-1259	Website: www.getman.com Contact: Greg Lockhart Phone: 269-427-5611 x308 E-mail: glockhart@getman.com					•		
Global Specialty Contractors, Inc. 3220 Terminal Dr Eagan, MN 55121	Contact: Zach Brazier Phone: 651-406-8232 E-mail: zach@globalspecialty.net				•			
Graciano Corporation 209 Sigma Drive Pittsburgh, PA 15238	Website: www.graciano.com Contact: Dave Sinclair Phone: 412-963-8400 x10155 E-mail: dsinclair@graciano.com				•			
Group Works LLC PO Box 7269 Wilton, CT 06897-7269	Website: www.groupworkslc.com Contact: James Scott Phone: 203-834-7905 E-mail: jamie@groupworkslc.com			•	•			
Gunitite Specialists Inc. 152 Mathers Rd Ambler, PA 19002-4100	Website: www.gunititespecialists.com Contact: David Reeves Phone: 610-239-0988 E-mail: info@gsipoolfinishes.com				•			
Gunitite Supply & Equipment Co. 1726 S Magnolia Ave Monrovia, CA 91016-4511	Website: www.gunititesupply.com Contact: Chris Marston Phone: 888-393-8635 E-mail: casales@gunititesupply.com					•		
Harris Rebar 7958 82nd St Delta, BC V4G 1L8, Canada	Website: www.harrisrebar.com Contact: Jeffrey Lea Phone: 604-946-1231 E-mail: jlea@harrisrebar.com						•	
Hayward Baker Inc. - Craig Olden Division PO Box 5000 Little Elm, TX 75068-9000	Website: www.oldeninc.com Contact: Trevor Bray Phone: 972-294-5000 E-mail: tbray@haywardbaker.com			•	•			
Hayward Baker Inc. 515 Nine North Ct Alpharetta, GA 30004-2961	Website: www.haywardbaker.com Contact: Ryan Smith Phone: 770-442-1801 E-mail: rtsmith@haywardbaker.com				•			
HCM Shotcrete 4-122 Earl Thompson Rd Ayr, ON N0B 1E0, Canada	Website: www.hcmshotcrete.ca Contact: David Ruhl Phone: 647-201-4006 E-mail: davidr@hcgroupp.ca				•			
High Country Pools, Inc. 6330 S College Ave Fort Collins, CO 80525	Website: www.highcountrypools.com Contact: Brad Spinuzzi Phone: 970-226-2657 E-mail: bspinuzzi@highcountrypools.com			•	•			

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Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Hydro Arch 900 W Warm Springs Rd, Ste 106 Henderson, NV 89011	Website: www.hydro-arch.com Contact: Andrea Scott Phone: 702-566-1700 E-mail: jmoore@hydro-arch.com				•			
Integrity Shotcrete Inc. Site 8 Box 32 RR 1 Millarville, AB T0L 1K0, Canada	Website: www.integrityshotcrete.com Contact: Nate Peterson Phone: 587-583-3345 E-mail: natepeterson@integrityshotcrete.com			•	•			
Island Pools, Inc. 20 E Line Rd Edgartown, MA 02539	Website: www.islandpools.com Contact: Ted Rosbeck Phone: 508-693-3040 E-mail: ted@rosbeck.com			•	•			
J Tortorella Swimming Pools Inc. 1764 County Road 39 Southampton, NY 11968-5204	Website: www.tortorella.com Contact: Joe Tortorella Phone: 631-728-1380 E-mail: info@tortorella.com	•		•	•			•
JCM Northlink LLC 123 Northeast 94th St Seattle, WA 98115	Website: www.jaydeecontr.com Contact: Nate Long Phone: 206-384-4685 E-mail: nlong@jaydee.us	•	•	•	•			
JE Tomes & Associates 2513 140th Pl Blue Island, IL 60406-3588	Website: www.jetomes.com Contact: Joseph E. Tomes Phone: 708-653-5100 E-mail: joe@jetomes.com	•	•					•
Jetcrete NA 2409 Albert Street N Regina, SK S4P 3E1, Canada	Website: www.thyssenmining.com Contact: Richard Miranda Phone: 306-949-6606 E-mail: rmiranda@jetcrete-na.com				•			
John Rohrer Contracting Company Inc. 2820 Roe Ln Kansas City, KS 66103-1543	Website: www.johnrohrercontracting.com Contact: Brandon D. McMullen Phone: 913-236-5005 E-mail: brandon@johnrohrercontracting.com				•			
Jones Excavating 5633 W Axel Park Rd West Jordan, UT 84081	Website: http://jonesexcavating.com Contact: Michael Parry Phone: 801-280-2809 E-mail: mikep@jonesshoring.com							
KHM Inc. PO Box 2672 Binghamton, NY 13902-2672	Contact: Kathleen Hall Phone: 607-773-0076 E-mail: khmwbe1989@stny.rr.com				•			
Kiewit Infrastructure Co. 470 Chestnut Ridge Rd Woodcliff Lake, NJ 07677	Contact: Paul Madsen Phone: 201-571-2730 E-mail: paul.madsen@kiewit.com				•			
King Shotcrete Solutions 3385 Harvester Rd PO Box 699 Burlington, ON L7R 3Y5, Canada	Website: www.kingshotcrete.com Contact: Joe Hutter Phone: 905-639-2993 E-mail: kingshotcrete@kpmindustries.com					•	•	•
Knowles Industrial Services Corp. 295 New Portland Rd Gorham, ME 04038-1867	Website: www.knowlesindustrial.com Contact: Dan Maloney Phone: 207-854-1900 E-mail: dmaloney@knowlesindustrial.com				•			
Kryton International Inc. 1645 East Kent Ave Vancouver, BC V5P 2S8, Canada	Website: www.kryton.com Contact: Sarah Rippin Phone: 604-324-8280 E-mail: info@kryton.com	•						

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Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Lanford Brothers Company Inc. PO Box 7330 Roanoke, VA 24019	Website: www.lanfordbrothers.com Contact: Patrick McDaniel Phone: 540-992-2140 E-mail: patm@lanfordbros.com			•				
Legal Pool Experts PO Box 412 Solana Beach, CA 92075	Website: http://legalpools.com Contact: Derek Downey Phone: 760-801-6566 E-mail: derek@legalpools.com			•				
Limen Group Const. Ltd. 46 Lepage Toronto, ON M3J 1Z9, Canada	Website: www.limengroup.com Contact: Amir Soleimani Phone: 416-638-8880 E-mail: asoleimani@limengroup.com							
Lithko Restoration Technologies, LLC 990 N Main St Monroe, OH 45050	Website: www.lithkorestoration.com Contact: Benny Hill Phone: 513-863-5500 E-mail: hillb@lithkorestoration.com				•	•	•	•
LRL Construction Co., Inc. PO Box 432 Tillamook, OR 97141	Website: www.lrlconstruction.com Contact: Denis Laviolette Phone: 503-842-5520 E-mail: info@lrlconstruction.com			•	•			
Madole Construction Co., Inc. 305 US Hwy 395 N Washoe Valley, NV 89704	Website: www.madoleconstruction.com Contact: Sean Madole Phone: 775-737-4414 E-mail: seanm@madoleconstruction.com				•			
Malcolm Drilling Co., Inc. 92 Natoma St, Ste 400 San Francisco, CA 94105	Contact: John Starcevich Phone: 206-510-7224 E-mail: jstarcevich@malcolmdrilling.com				•			
Mapei Corporation 2516 Soapstone Drive Reston, VA 20191	Website: www.utt-mapei.com Contact: Wesley Morrison Phone: 571-524-2484 E-mail: wmorrison@mapei.com	•						•
Mar-Allen Concrete Products Inc. 490 Millway Rd Ephrata, PA 17522-9528	Contact: Jeffrey L. Zimmerman Phone: 717-859-4921 E-mail: jlzimmerman@marallen.com				•			
Mays Construction Specialties Inc. 2399 Riverside Parkway Grand Junction, CO 81505	Website: www.mays-mcsi.com Contact: Kyle R. Vanderberg Phone: 970-245-0834 E-mail: kvanderberg@mays-mcsi.com				•			
McGill Restoration Inc. 2821 Grebe St Omaha, NE 68112	Website: www.mcgillrestoration.com Contact: Darin Cielocha Phone: 402-558-7989 E-mail: dcielocha@mcgillrestoration.com				•			
Metro Testing Laboratories (Concrete Restoration) Ltd. 6961 Russell Ave Burnaby, BC V5J 4R8, Canada	Website: www.metrotesting.ca Contact: Neil McAskill Phone: 604-436-9109 E-mail: nmcaskill@metrotesting.ca			•	•			
Mid-American Group 8475 Port Sunlight Rd Newport, MI 48166	Contact: Lawrence I. Masserant Phone: 734-586-8868 E-mail: lcmasserant@midamericangroup.com							
Mid-American Gunitite Pools Inc. 3152 Crescent Ave Erlanger, KY 41018	Website: www.midamericanpools.com Contact: Patrick M. Brennan Phone: 859-581-8566 E-mail: pool1boss@fuse.net				•			

Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Mid-West Gunitite, LP 11736 Missouri Bottom Rd, Ste B Hazelwood, MO 63042	Contact: Horacio Yanez Phone: 314-731-7575 E-mail: midwestgunitite.jhyp@gmail.com			•	•			
Minova Global 150 Summer Ct Georgetown, KY 40324-9303	Website: www.minovaglobal.com Contact: JW Jones Phone: 502-542-4973 E-mail: jw.jones@minovaglobal.com							•
Montana Manroc Developments PO Box 1264 Columbus, MT 59019	Website: www.montanamanroc.com Contact: Mike Hare Phone: 406-328-7268 E-mail: mikehare.manroc@yahoo.com				•			
Morrison Engineers PLLC 7701 Chapel Hill Rd Raleigh, NC 27607-4988	Website: www.morrisonengineers.com Contact: James Hoover Phone: 919-851-2021 E-mail: james@morrisonengineers.com			•	•			
Mosites Construction Company 4839 Campbells Run Road Pittsburgh, PA 15205	Website: www.mosites.com Contact: Erik Bertrand Phone: 412-923-2255 E-mail: erikb@mosites.com				•			
Mud Slingers Pool & Patio 5575 Elmwood Ave, Ste D Indianapolis, IN 46203	Website: www.mudslingersinc.com Contact: Kim Harper Phone: 317-650-5131 E-mail: sales@mudslingersinc.com	•	•	•	•			•
The Nassal Company 415 W Kaley St Orlando, FL 32806-3942	Website: www.nassal.com Contact: Melissa Ruminot Phone: 407-648-0400 E-mail: mruminot@nassal.com			•	•			
National Gunitite 111 Roosevelt Blvd Johnstown, PA 15906-2736	Website: www.nationalgunitite.com Contact: Lee Taylor Phone: 814-533-5780 E-mail: ltaylor@nationalgunitite.com				•			
National Pools of Roanoke Inc. 3112 Melrose Ave NW PO Box 6354 Roanoke, VA 24017-5916	Website: www.nationalpools.com Contact: Jason Vaughan Phone: 540-345-7665 E-mail: jason@nationalpools.com				•			
Nationwide Shotcrete Inc. 23638 Lyons Ave, Ste 273 Newhall, CA 91321-2513	Website: http://nationwideshotcrete.com Contact: Jordan Harpole Phone: 661-799-3750 E-mail: jon@nationwideshotcrete.com			•	•			
New York Concrete Corp. 708 Sharrotts Rd Staten Island, NY 10309	Website: http://newyorkconcrete.com Contact: Tom Solimeo Phone: 718-967-3720 E-mail: tsolimeo@newyorkconcrete.com				•			
NMN Construction 16275 Filbert St Sylmar, CA 91342	Website: www.nmnconstruction.com Contact: Rod Federico Phone: 714-389-2104 E-mail: ron.federico@nmnconstruction.com				•			
Normet Americas Inc. 1681 Renaissance Blvd Sturtevant, WI 53177	Website: www.normet.fi/contacts/region_americas_contacts Contact: Chris Gause Phone: 262-878-5760 E-mail: chris.gause@normet.fi	•	•	•		•		
Olin Engineering Inc. 15622 Computer Ln Huntington Beach, CA 92649-1608	Website: www.olinpump.com Contact: David O. Swain Phone: 714-897-1230 E-mail: dave@olinpump.com					•		

Buyers Guide

Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Oscar Orduno, Inc. 4500 Fuller Drive, Ste 205 Irving, TX 75038	Website: www.oscarorduno.com Contact: Oscar Orduno Phone: 972-717-3070 E-mail: oorduno@oscarorduno.com				•			
Osco Mudjacking & Shotcreting Ltd. 4174 – 95 Street NW Edmonton, AB T6E 6H5, Canada	Website: www.mudjacking.com Contact: Larry Hnatiuk Phone: 780-469-1234 E-mail: osco@mudjacking.com				•			
Palmetto Guniting Construction Company Inc. PO Box 388 Ravenel, SC 29470-0388	Website: www.palmettoguniting.com Contact: Thomas A. Hendricks Phone: 843-889-2227 E-mail: tommy@palmettoguniting.com				•			
ParCrete Equipment 4-5511 Steeles Ave W Toronto, ON M9L 1S7, Canada	Website: www.parcrete.ca Contact: Murray Smith Phone: 416-745-5511 E-mail: murray@parcrete.ca					•		
PCiRoads LLC 14123 42nd St NE Saint Michael, MN 55376-9564	Website: www.pciroads.com Contact: Dave Graham Phone: 763-497-6100 E-mail: dgraham@pciroads.com				•			
PLI Systems, Inc. 3045 SE 61st Ct Hillsboro, OR 97123-3113	Website: www.plisystems.com Contact: Manuel Castaneda Phone: 503-649-8111 E-mail: peter@plisystems.com				•			
Polycrete Restorations Ltd. 202-204 Cayer Street Coquitlam, BC V3K 5B1, Canada	Contact: Balraj Mann Phone: 604-521-4300 E-mail: info@polycreterestorations.com			•	•			
Pool Engineering Inc. 1201 N Tustin Ave Anaheim, CA 92807-1646	Website: www.pooleng.com Contact: Ron Lacher Phone: 714-630-6100 E-mail: ronl@pooleng.com			•	•			
Precon Marine Inc. 1401 Precon Dr , Ste 102 Chesapeake, VA 23320-6314	Website: www.preconmarine.com Contact: Matthew Miller Phone: 757-545-4400 E-mail: agemmell@preconmarine.com				•			
Preload LLC 4000 Tower Road Louisville, KY 40219	Website: www.preload.com Contact: Donald Cameron Phone: 631-231-8100 E-mail: dcameron@preload.com				•			
Prestige Concrete Products 7228 Westport Pl West Palm Beach, FL 33413-1683	Website: www.prestige-guniting.com Contact: Greg McFadden Phone: 561-478-9980 E-mail: gwmcfadden@prestige-concrete.com			•	•			•
Prometheus Construction 1024 Queen St Honolulu, HI 96814	Website: www.prometheusconstruction.com Contact: Brian Mahnken Phone: 808-864-0460 E-mail: brian@prometheusconstruction.com				•			
Promiz, LLC 530 Madison Ave, Bldg 3 Junction City, IL 62882	Website: http://cem-mend.com Contact: Kevin L. Hickman Phone: 618-533-3950 E-mail: kevin@promizllc.com			•	•			•
ProShot Concrete Inc. 4158 Musgrove Dr Florence, AL 35630-6396	Website: www.proshotconcrete.com Contact: Patrick A. Mooney Phone: 256-764-5941 E-mail: patm@proshotconcrete.com				•			

Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Proshot Structures 13478 Woodcrest Dr Surrey, BC V4P 1W6, Canada	Website: http://pro-shot.ca Contact: Doug Smith Phone: 604-531-8927 E-mail: dsmith@pro-shot.ca				•			
Pullman-Shared Systems Technology, Inc. 2227 High Hill Rd Swedesboro, NJ 08085	Website: www.pullman-services.com Contact: Joe Munch Phone: 856-553-4210 E-mail: jmunch@pullman-services.com							
Putzmeister Shotcrete Technology 1733 90th St Sturtevant, WI 53177-1805	Website: http://putzmeistershotcrete.com Contact: Robert J. Harmon Phone: 610-909-9519 E-mail: harmonb@putzam.com					•		
The Quikrete Companies 8530 Delaware Ave North Huntingdon, PA 15642	Website: www.quikrete.com/shotcrete Contact: Dennis Bittner Phone: 412-759-1333 E-mail: dbittner@quikrete.com		•					•
Quikspray, Inc. PO Box 327 Port Clinton, OH 43452	Website: www.quikspray.com Contact: Leah Barker Phone: 419-732-2611 E-mail: leah@quikspray.com					•		
R. W. Haggerty Pool Service Inc. 1 Emerald St Norwalk, CT 06850	Website: www.haggertypools.com Contact: Roger Haggerty Phone: 203-348-6899 E-mail: rhaggerty@haggertypools.com			•	•	•		
Ralph L Wadsworth Construction Company 166 E 14000 S Draper, UT 84020-5441	Website: www.wadsco.com Contact: Tera Wadsworth Phone: 801-553-1661 E-mail: tera@wadsco.com				•			
Ram Construction Services 13800 Eckles Rd Livonia, MI 48150-1041	Website: www.ramservices.com Contact: Tom Szabo Phone: 734-464-3800 E-mail: tszabo@ramservices.com			•	•			
Ram Jack of Charlotte, LLC PO Box 2991 Huntersville, NC 28070-2991	Website: www.ramjackcharlotte.com Contact: Mark Beckham Phone: 704-892-2900 E-mail: markramjack@bellsouth.net				•			
REED Shotcrete Equipment 13822 Oaks Ave Chino, CA 91710-7008	Website: www.reedpumps.com Contact: Mike Newcomb Phone: 909-287-2100 E-mail: mike.newcomb@reedmfg.com					•		
Reprecrete Concrete Repairs & Cont. Co. PO Box 45962 Abu Dhabi, United Arab Emirates	Website: www.reprecreteuae.com Contact: Khaled Naddeh Phone: 01197126336128 E-mail: reprecrete@emirates.net.ae				•			
Restek Inc. 6601 Boucher Dr Edmond, OK 73034-8582	Website: www.restekinc.net Contact: Ellery N. Brown Phone: 405-330-3950 E-mail: restek@flash.net				•			
Restoration East, LLC 4209 E Chase St Baltimore, MD 21205-3020	Website: www.restorationeast.com Contact: Louis Helmacy Phone: 410-563-4972 E-mail: louh@restorationeast.com				•			
Revolution Gunite 3580 S Church St Burlington, NC 27215	Website: www.revolutiongunite.com Contact: Ryan Oakes Phone: 336-383-1718 E-mail: ryan@revolutiongunite.com			•	•			

Buyers Guide

Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Riverdale Mills Corp. PO Box 200 Northbridge, MA 01534-0200	Website: www.riverdale.com Contact: Christine Albone Phone: 800-762-6374 E-mail: lrwalsh@riverdale.com						•	
Russo Corporation 1421 Mims Avenue SW Birmingham, AL 35211	Website: www.russocorp.com Contact: Harris Wilson Phone: 205-923-4434 E-mail: hwilson@russocorp.com			•	•			
San Joaquin Gunitite 5868 E Mustang Clovis, CA 93619	Website: www.sanjoaquinunitite.com Contact: Scott Santellan Phone: 559-285-8965 E-mail: sanjoaquinunitite@gmail.com				•			•
Schnabel Foundation Company 2950 S Jamaica Ct, Ste 107 Aurora, CO 80014-2686	Website: www.schnabel.com Contact: Todd Duncan Phone: 303-696-7268 E-mail: todd@schnabel.com				•			
Schwing America, Inc. 5900 Centerville Rd Saint Paul, MN 55127	Website: www.schwing.com Contact: Jason Zignego Phone: 651-429-0999 E-mail: jzignego@schwing.com					•		
Selinsky Force 4244 Mt Pleasant St NW, Ste 100 North Canton, OH 44720	Contact: Bryon Bates Phone: 330-477-4527 E-mail: bryon.bates@selinskyforce.com				•			
Shannon & Wilson Inc. 400 N 34th St, Ste 100 Seattle, WA 98103	Website: http://shannonwilson.com Contact: Axel Nitschke Phone: 206-695-6822 E-mail: agn@shanwil.com			•				
Shotcrete Africa SCP (Pty) Ltd. PO Box 1709 Jukskei Park, NS 2153, South Africa	Website: www.shotcrete.co.za Contact: Dustin Strever Phone: 011-27110274337 E-mail: dustin@shotcrete.co.za		•	•	•	•	•	•
Shotcrete Contractors Inc. 1055 Long Hollow Rd La Follette, TN 37766	Website: http://shotcretecontractors.com Contact: Michael Milton Phone: 423-449-8407 E-mail: mmiltonhb@aol.com				•			
Shotcrete Helmet PO Box 430 Stn Main Paris, ON N3L 3T5, Canada	Website: www.shotcretehelmet.com Contact: The St George Company Phone: 519-442-2046 E-mail: info@shotcretehelmet.com					•		
Shotcrete Montana 2323 Minnesota Ave Billings, MT 59101	Website: www.shotcretetemt.com Contact: Lucille Mooney Phone: 406-206-4711 E-mail: lucille@shotcretemt.com				•	•	•	•
Shotcrete Technologies Inc. PO Box 3274 Idaho Springs, CO 80452-3274	Website: www.shotcretetechnologies.com Contact: Kristian Loevlie Phone: 303-567-4871 E-mail: kristian@shotcretetechnologies.com	•	•	•	•			
Sika Corporation 201 Polito Ave Lyndhurst, NJ 07071-3601	Website: www.sikaconstruction.com Contact: Ketan Sompura Phone: 201-508-6698 E-mail: sompura.ketan@sika-corp.com	•	•					
Sika Schweiz AG, Aliva Equipment Tuffenwies 16 Zurich 8048, Switzerland	Website: www.aliva-equipment.com Contact: Matthias Hagler Phone: 011-41584363287 E-mail: haegler.matthias@ch.sika.com					•		

Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Sofis Company Inc. 554 Bocktown Cork Rd Clinton, PA 15026-1142	Website: www.sofiscompany.com Contact: Ted W Sofis Phone: 724-378-2670 x2 E-mail: tsofis@sofiscompany.com			•	•			
South Bay Gunit Company 7130 Mayard Rd Houston, TX 77041	Contact: Andres Curiel Phone: 713-932-6669 E-mail: andressbg@aol.com		•	•	•			•
South Shore Gunit Pools & Spas Inc. 12 Esquire Road North Billerica, MA 01862	Website: www.ssgpools.com Contact: Robert E. Guarino Phone: 800-649-8080 E-mail: rguarino@southshoregunitpools.com			•	•			
Southwest Contracting Ltd. 9426 - 192nd Street Surrey, BC V4N 3R9, Canada	Website: www.southwestcontracting.ca Contact: Scott MacCara Phone: 604-888-5221 E-mail: scott@southwestcontracting.ca				•			
Southwest V-Ditch Inc. 3625 Placentia Ln Riverside, CA 92501-1119	Website: www.swvditch.com Contact: Bob Shepherd Phone: 951-781-4303 x18 E-mail: mail@swvditch.com				•			
SPB Torkret Ltd. sp z.o.o. spolka komandytowa, ul. Grabowa 8 Siekierki Wielkie, Wielkopolska 62-025 Poland	Website: www.torkret.com.pl Contact: Wlodzimierz Czajka Phone: 486-189-7810 x2 E-mail: czajka@torkret.com.pl			•	•			
Spec Mix Inc. 1230 Eagan Industrial Rd, Suite 160 Eagan, MN 55121-1293	Website: www.specmix.com Contact: Leah Cory Phone: 651-994-7120 E-mail: nblohowiak@specmix.com		•	•		•	•	•
SpecChem LLC 1511 Baltimore Ave, Suite 600 Kansas City, MO 64108	Website: www.specchemllc.com Contact: Michael LeMark Phone: 816-968-5600 E-mail: mlemark@specchemllc.com							
Specialty Concrete Services LLC 5437 Mahoning Ave, Suite 24 Austintown, OH 44515	Contact: John Lucci Phone: 330-953-3677 E-mail: john@specialty-concrete.com				•			
SprayForce Concrete Services Ltd. #3, 3227 - 56th Avenue SE Calgary, AB T2C 2A7, Canada	Website: www.sprayforceconcrete.com Contact: Jay Unruh Phone: 403-570-0438 E-mail: info@sprayforceconcrete.com			•	•			
Stone Valley Construction Inc. 132 Coaldale Rd Philipsburg, PA 16866-2333	Website: www.stone-valley.com Contact: Ken Knepp Phone: 814-342-7151 E-mail: kknepp@stone-valley.com			•	•			
Strata Mine Services 67925 Bayberry Dr Saint Clairsville, OH 43950-9132	Website: www.strataworldwide.com Contact: Richard Werth Phone: 740-695-6880 E-mail: rwerth@stratamineservices.com				•			
Structural Shotcrete Ltd 18453 67a Avenue Surrey, BC V3S 9B3, Canada	Contact: Lorne Rutt Phone: 604-575-2563 E-mail: lorne@structuralshotcrete.ca				•			
Structural Shotcrete Systems Inc. 12645 Clark St Santa Fe Springs, CA 90670-3951	Website: www.structuralshotcrete.com/index.html Contact: Jason Weinstein Phone: 562-941-9916 E-mail: jason1@structuralshotcrete.com				•			

Buyers Guide

Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
StructureWerks 12600 Robin Ln, Suite 100 Brookfield, WI 53005-3124	Website: www.structurewerks.com Contact: Ross Preschat Phone: 262-781-4329 E-mail: rpreschat@structurewerks.com			•	•			
Subsurface Construction Company 1107 Fuller St Raleigh, NC 27603	Website: www.subsurfaceconstruction.com Contact: Alex Smith Phone: 919-857-4609 E-mail: alex@subsurfaceconstruction.com				•			
Summit Shotcrete 4387 Briarwood Ln Lehi, UT 84043	Website: http://summitshotcrete.com Contact: Therin Ramos Phone: 435-862-2803 E-mail: therin@summitshotcrete.com			•	•			
Sunwest Gunit Co. 7045 Luella Anne Dr NE Albuquerque, NM 87109-3907	Website: www.sunwestgunitco.com Contact: Gary O'Canna Phone: 505-821-2549 E-mail: garyocanna@gmail.com			•	•			
Superior Gunit 12306 Van Nuys Blvd Lake View Terrace, CA 91342	Website: www.shotcrete.com Contact: Steven Crawford Phone: 818-896-9199 E-mail: steve.crawford@shotcrete.com				•			
TBH & Associates LLC 5211 NE 88th St Vancouver, WA 98665	Website: www.tbhdrill.com Contact: Peter A Tapio Phone: 360-546-1600 E-mail: rlarsen@tbhdrill.com			•	•			
Terra Engineering & Construction Corporation 2409 Vondron Rd Madison, WI 53718	Website: www.whytterra.com Contact: Gary F. Zimmerman Phone: 608-210-3918 E-mail: gzimmerman@whytterra.com				•			
Testing, Engineering & Consulting Services Inc. 235 Buford Dr Lawrenceville, GA 30046-4945	Website: www.tecservices.com Contact: James Glenn McCants III Phone: 770-995-8000 E-mail: tmccants@tecservices.com			•				
Texaloy Foundry Company Inc. PO Box 37 Floresville, TX 78114-0037	Website: www.texaloy.com Contact: Jack Rice Phone: 800-367-6518 E-mail: jrice@texaloy.com					•		
Texan Gunit 2406 Narrow Valley Dr Cedar Park, TX 78613	Contact: Juanjose Armenta-Aguirre Phone: 512-383-5341 E-mail: texanccs@gmail.com		•	•		•		•
Texas Shotcrete Inc. 709 Tower Ln McKinney, TX 75069-1805	Contact: Dan Goplin Phone: 972-872-1901 E-mail: dan@texasshotcrete.com							
Thiessen Team USA Inc. PO Box 40 Elko, NV 89803-0040	Website: www.thiessenteam.com Contact: James Schumacher/Jessica Florence Phone: 775-777-1205 E-mail: jschumacher@thiessenteam.com	•		•	•	•	•	•
Thorcon Shotcrete & Shoring LLC 5460 Montana Vista Way Castle Rock, CO 80108	Website: www.thorconshotcrete.com Contact: Michael Klomp Phone: 303-802-8640 E-mail: info@thorconshotcrete.com		•	•	•			
Top Gun of Virginia Inc. 10017 Richmond Hwy Lorton, VA 22079-2421	Website: www.topgungunit.com Contact: George Benko Phone: 703-550-9207 E-mail: info@topgungunit.com				•			

Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Top Shot Concrete Inc. 3807 Arthur Rose Avenue Saskatoon, SK S7P 0C7, Canada	Website: www.topshotconcrete.com Contact: Pat Donovan Phone: 306-242-4155 E-mail: pat@topshotconcrete.com	•	•	•	•	•	•	•
Topcor Services Inc. 12025 Industriplex Blvd Baton Rouge, LA 70809-5131	Website: www.topcor.com Contact: James M. Baker Phone: 225-753-7067 E-mail: jlbaker@topcor.com			•	•			
Torrent Shotcrete Structures Ltd. 207-53 West Hastings Street Vancouver, BC V6B 1G4, Canada	Website: http://torrentshotcrete.com Contact: Gary Hawkins Phone: 778-239-4722 E-mail: garyh@torrentshotcrete.com				•			
Triforce Construction Inc. PO Box 5846 Garden Grove, CA 92846	Contact: Carlos Martinez Phone: 714-895-6500 E-mail: triforce.teri@gmail.com				•			
Tri-State Guniting LP 101 Sterling Mine Rd Sloatsburg, NY 10974	Contact: Pablo Yanez Phone: 845-406-8122 E-mail: pablolistate@yahoo.com	•	•	•	•	•		•
Truesdell Corporation 1310 W 23rd St Tempe, AZ 85282-1837	Website: www.truesdellcorp.com Contact: Kurt Clink Phone: 602-437-1711 E-mail: kclink@truesdellcorp.com				•			
Turnstone Construction, Inc. 925 NE Boat St Seattle, WA 98105	Website: www.turnstoneconstruction.com Contact: John Fulford Phone: 425-881-0218 E-mail: john@turnstoneconstruction.com				•			
Vancouver Shotcrete & Shoring Inc. #105 - 10185 199B Street Langley, BC V1M 3W9, Canada	Website: www.shotcreteshoring.com Contact: Ravi Gill Phone: 604-881-4898 E-mail: info@shotcreteshoring.com			•	•			
Wagman Heavy Civil 3290 N Susquehanna Trl York, PA 17406	Website: www.wagman.com Contact: Ed Laczynski Phone: 717-764-8521 E-mail: erlaczynski@wagman.com			•				
Western Grater Contracting Ltd. 790 Industrial Way Victoria, BC V9B 6E2, Canada	Website: www.westerngrater.com Contact: Dustin Krizsan Phone: 250-478-4225 E-mail: dustin@westerngrater.com							
Western Materials & Design, LLC PO Box 1157 Harrisonville, MO 64701	Website: www.wmdus.com Contact: Clint Reeves Phone: 816-380-4747 E-mail: creeves@wmdus.com		•			•		
Western Shotcrete Equipment Inc. HC 1 Box 193 Fairdealing, MO 63939-9708	Website: www.wseshotcrete.com Contact: Joe Harpole Phone: 573-857-2085 E-mail: josephharpole@wseshotcrete.com					•		
Westport Pools 156 Weldon Pkwy St Louis, MO 63043-3102	Contact: Ryan Casserly Phone: 314-432-1801 E-mail: rcasserly@westportpools.com				•			
Whiteside Construction Corporation 1151 Hensley St Richmond, CA 94801-2162	Website: www.wesconshotcrete.com Contact: David Whiteside Phone: 510-234-6681 E-mail: drw@whitesideconstruction.com				•			

Buyers Guide

Name/Address	Contact information	Specialties						
		Admixtures	Cement/ Pozzolanic Matl	Consulting	Contractor	Equipment	Fibers	Shotcrete Materials/Mixes
Wildcat Concrete Services Inc. PO Box 750075 Topeka, KS 66675-0075	Website: http://wildcatcompanies.com/concrete.html Contact: Stuart R. Johnson Phone: 785-233-1400 E-mail: stuartj@wildcatconcrete.com				•			
William L Watson Company 8064 N Main Street Eden, NY 14057	Contact: Matt Friedrich Phone: 716-992-3220 E-mail: wlwatsonpools@verizon.net				•			
WR Grace 7500 Grace Dr Columbia, MD 21044	Website: www.grace.com Contact: Stella Ip Phone: 410-531-8846 E-mail: stella.ip@grace.com		•					
Wright Concrete & Construction, Inc. 9430 US 23 S Pikeville, KY 41501	Website: www.wrightconcrete.com Contact: Shannon Wright Phone: 606-639-4484 E-mail: j.bentley@wrightconcrete.com		•	•	•			
Wurster Engineering & Construction 34 Carrie D Greenville, SC 29615-5611	Website: www.wursterinc.com Contact: Daryl Wurster Phone: 864-627-7751 E-mail: daryl.wurster@wursterinc.com				•			
Xtreme Shotcrete 166 Woodside Ave Winthrop, MA 02152-2063	Website: http://xtremeshotcretema.com Contact: Michael Anthony Whitehead Phone: 617-846-3191 E-mail: whitehead0015@aol.com				•			

www.Shotcrete.org/BuyersGuide

Grab your camera

Working on an interesting
shotcrete project?

Proud of the work you shoot?

TAKE A PICTURE!

Take several! From beginning to end, photos add a lot to the story. If you have high-quality/print-resolution photos to support the work you do, you could enter your project for ASA's Outstanding Shotcrete Project Awards Program. So start taking pictures today!



american
shotcrete
association

asa

www.Shotcrete.org/ASAOutstandingProjects

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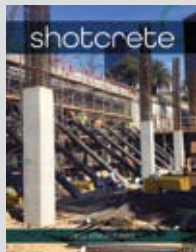
shotcrete brochures



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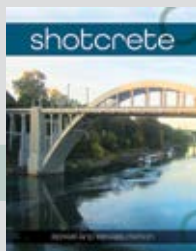
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